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Gradering

Laget av

Bengt Hultberg

Undertittel

Tittel

PETROPHYSICAL EVALUATION

WELL 34/10-16

OCTOBER 1983

LET-BERGEN

Utarbeidet

Godkjent

CONTENTS

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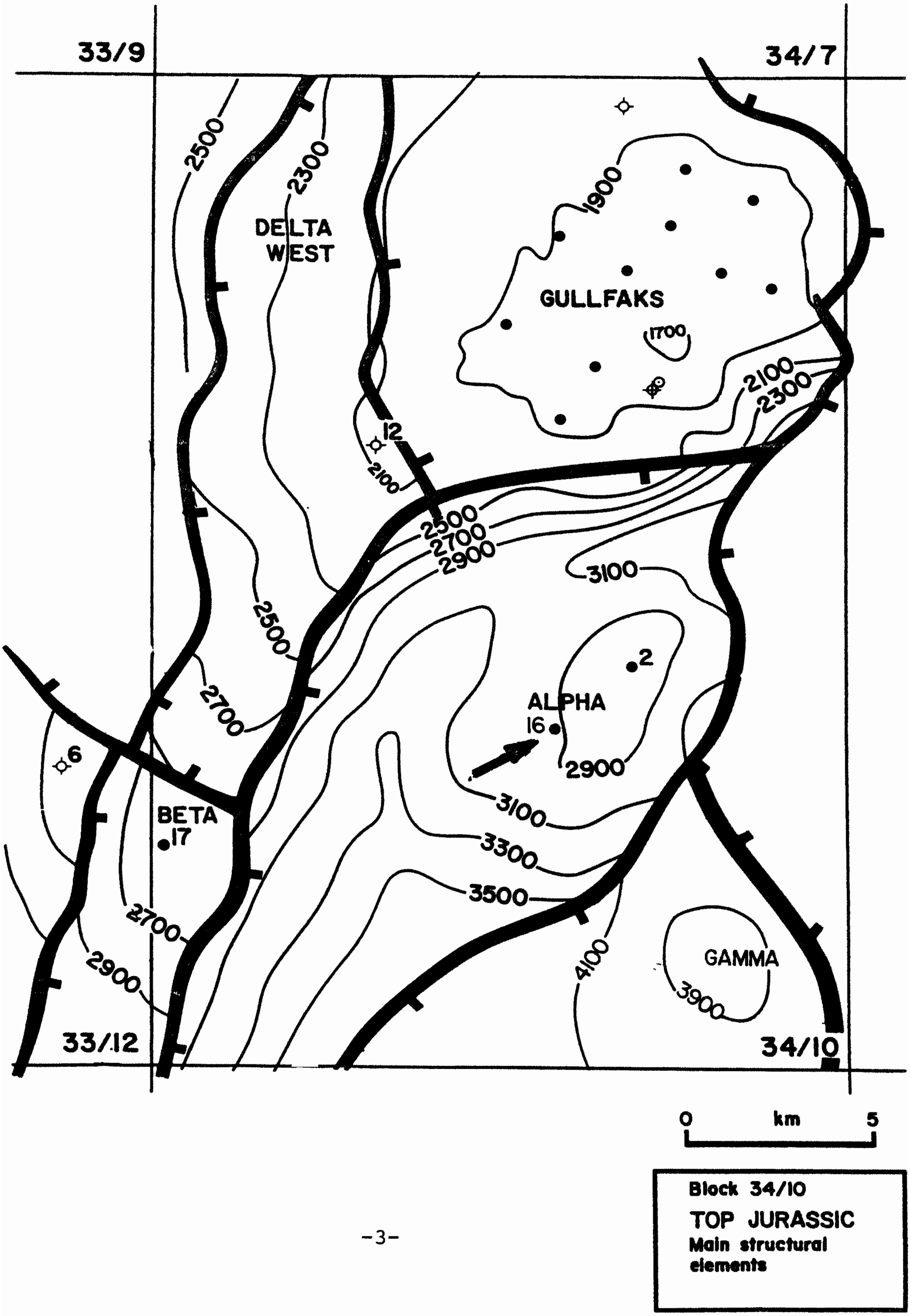
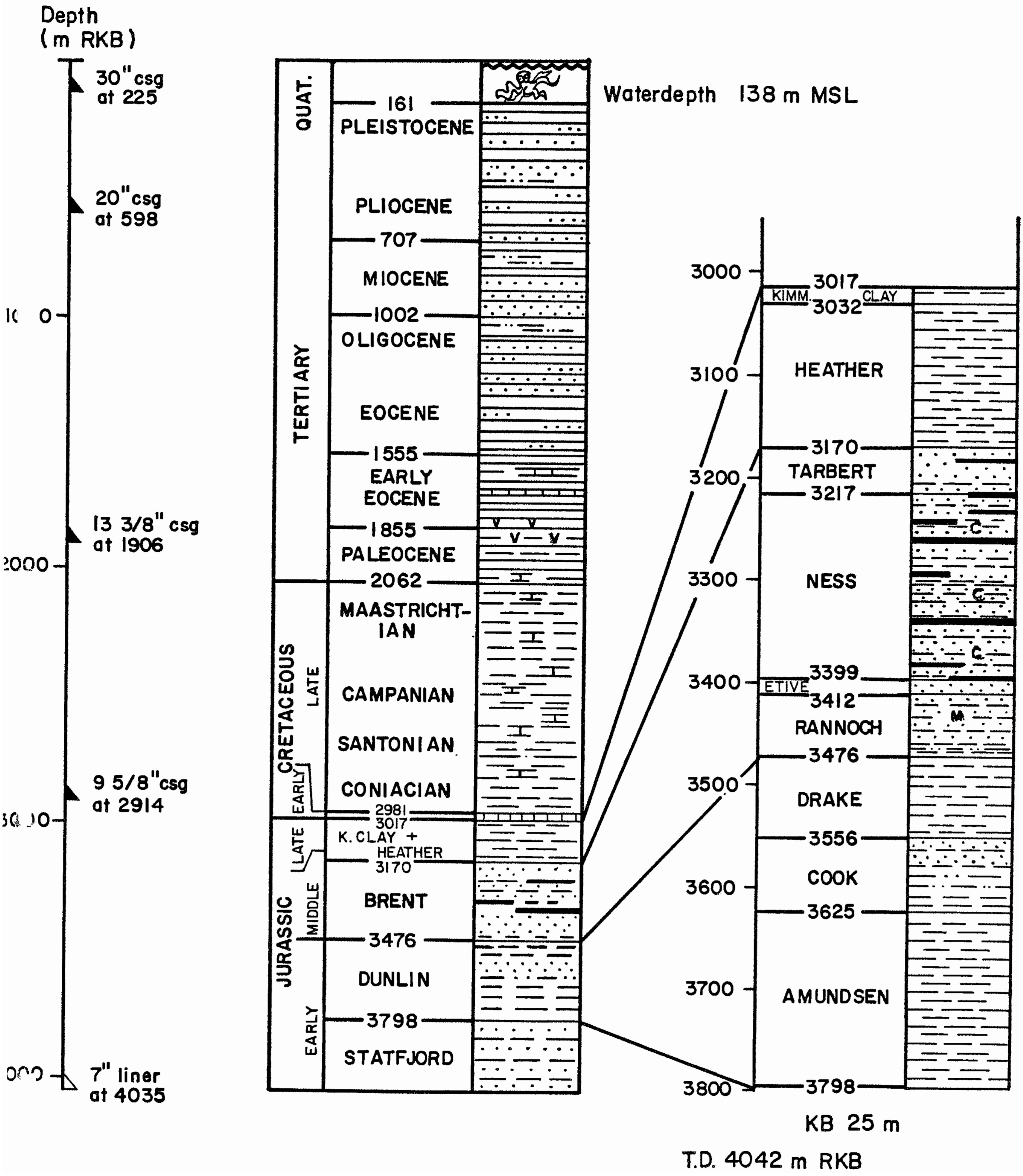
GENERAL

Licence:	PL 050
Well:	34/10-16
Location:	61°05'36" N 02°10'47" E
Rig:	Neptuno Nordraug (drilling) Ross Isle (testing)
Spudded:	14 December 1982
Rig Released:	13 April 1983
Reentered:	30 August 1983
Rig released:	28 September 1983
RKB-elevation:	25m (N. Nordraug) 22m (Ross Isle)
Water Depth:	138m
Total Depth:	4042m
Objective:	Jurassic Sandstones
Operator:	Statoil
Partners:	Norsk Hydro, Saga Petroleum
Status:	Plugged and Abandoned


33/9
34/7
DELTA WEST
GULLFAKS
1900
1700
2100
2300
2500
12
ALPHA
16
2
2900
3100
3300
3500
BETA
17
6
2700
GAMMA
3900
4100
33/12
34/10
0 km 5
Block 34/10
TOP JURASSIC
Main structural elements

34/10-16

GENERALIZED STRATIGRAPHY



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INTRODUCTION

Well 34/10-16 is the second well drilled on the Alpha structure in block 34/10.

The well was drilled into Triassic age to a total depth of 4042 m RKB.

The two primary objectives were sandstones of middle- and lower Jurassic age, the Brent and Statfjord formations.

The Brent formation was found to be hydrocarbonbearing while no hydrocarbons were encountered in the Statfjord formation.

This report contains a petrophysical evaluation of the Brent formation, using electrical logs and core data.

SUMMARY

The Brent formation was hydrocarbon bearing. The oil-water contact was picked from the logs at approximately 3422m RKB and the gas-oil contact at approximately 3350 m RKB. The Brent formation contains about 84.0 m net pay gas bearing sand (average Ø: 18.2%, S_w: 22.5%) and approximately 29.5 m net pay oil-bearing sand (average Ø: 16.5%, S_w: 38.9%).

Two DSTs were performed in September 1983 with the following results:

DST No.1 (3397 - 3407 m RKB, Ross Isle), 48/64" choke.

Oil rate: 960 Sm^3/d
Gas rate: 182 x 10^3 Sm^3/d

DST No.2 (3177 - 3187 m RKB, Ross Isle), 80/64" choke.

Condensate rate: 370 Sm^3/d
Gas rate: 1650 x 10^3 Sm^3/d

Two RFT-A runs were also made and the results from these proved that the gas-oil contact is between these to sampling points, 3348 and 3359 m (logging depth).

RESULTS

The petrophysical parameters are as follows:

Formation interval (m RKB)	Thickness (m)	Sand (m)	Avg.Porosity %	Avg. S_w %	Avg. V_{sh} %	Net/Gross %
Tarbert (3171 - 3217)	46	40.25 / 40.5	19.1 / 19.0	15.8 / 16.0	8.9 / 9.1	87.5 / 88.0
Ness (3217 - 3399)	182	53.75 / 55.25	17.3 / 17.2	30.6 / 31.7	18.8 / 19.0	29.5 / 30.4
Etive (3399 - 3412)	13	13.0 / 13.0	18.0 / 18.0	30.1 / 30.1	3.2 / 3.2	100.0 / 100.0
Rannoch (3412 - 3475)	63	7.5 / 42.75	12.7 / 14.1	55.0 / 79.8	0.6 / 6.7	11.9 / 67.9
Brent (3171 - 3475)	304	114.5 / 151.5	17.7 / 16.9	26.9 / 41.0	12.4 / 11.5	37.7 / 49.8

Legend: Net pay / Net sand

The following cut-off criteria were used:

Net sand: V_{sh} > 40%, Ø < 10%

Net pay: V_{sh} > 40%, Ø < 10%, S_w > 65%

LOG QUALITY

Information from this well is somewhat reduced because of hole problems. It was impossible to get the dual laterolog below about 3220 m RKB. From this point downwards we only have the induction log as a deep reading resistivity device, which is unreliable at high resistivities.

Schlumberger was asked to do corrections and merging of the Rild and DLL and to caluclate R_{xo} and R_t. The R_{xo} and R_t curves used in this report are the ones received from Schlumberger.

The tension curve indicates that the FDC/CNL log may have been stuck over some intervals. These intervals are shown in the table below.

Measuring point, mRKB	Position of FDC	Position of CNL
3275 - 3279.5	-1.1m	-7.4m
3280 - 3282	"	"
3351 - 3353	"	"
3377 - 3384	"	"

All cores have been depth shifted in order to match the logs.

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GEOLOGY

The Brent Formation

Tarbert: Shoreface/upper shoreface sand. Very fine to coarse, micaceous in the lower part. Contains one coal layer. Upper Tarbert well sorted.

Ness: Lower and upper delta plain deposits including bay fill/marsh/river channel sequences. Numerous coal layers. Micaceous.

Etive: Distributary mouth bar (?) sand. Coarse to fine, less micaceous than the Rannoch formation. Large and small scale crossbedding. Heavy mineral zones.

Rannoch: Prodelta/delta front sheet sand. Medium to very fine, micaceous, heavy mineral zones. Plane parallel lamination and low angle cross stratification. Mica content decreasing upwards.

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INPUT PARAMETERS

The input parameters were picked from crossplots, histograms, measured data and empirical relationships.

Water Resistivity

The water resistivity value is based on the results from 34/10-2 and 34/10-3. A salinity of 44.000 ppm was used, which gives a resistivity of 0.056 ohmm at 96^{o}C.

Hydrocarbon Density

In the gas zone 0.28 g/cc is used and in the oil zone 0.85 g/cc.

Shale Volume

Several shale indicators were tried in order to get a reasonable Vshale curve. Most of the different indicators, however, gave unacceptable results. The final Vshale curve in Tarbert, Etive and Rannoch is calculated from the neutron curve. In the Ness formation the thorium and potassium values were used to calculate Vshale.

The porosity derived from the logs corrected for shaliness deviate in parts from the core porosity. These uncertainties are best seen in the shaly sections. These differences have a minor influence on the statistics in the pay zones as the derived log porosity agrees fairly well with the core porosity in the clean sands.

The core porosity has not been corrected for the overburden effect and is therefore higher than the in situ porosity.

The difficulty in finding a correct shale volume is due to mica and heavy mineral problems. A quick-look at some thin sections indicates up to 20 - 30% mica and 1 - 2 % zircon in places. This has a great influence on the gamma ray curve. The neutron curve, however, seems to be fairly unaffected by these minerals. See special report in appendix.

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Mud properties

The following values are reported by Schlumberger:
(ISF-LSS-GR-MSFL, run no.4 31/3/83)

R_m : 0.158 ohmm at 115.5 ^oC

R_{mf} : 0.086 ohmm at 115.5 ^oC

R_{mc} : 0.242 ohmm at 115.5 ^oC

A mud filtrate resistivity of 0.1 ohmm at 97 ^oC is used in this evaluation.

Other Parameters

	Tarbert and Ness	Etive and Rannoch
ρ_{sh}	2.48 g/cc	2.50 g/cc
R_{sh}	3.0 ohmm	4.0 ohmm
$\emptyset_{Nsh}$	0.33	0.32
$\emptyset_{heavy\ mineral}$	0.22	0.22
Th_{max} (Ness)	15.5 ppm	
Th_{min} (Ness)	2.0 ppm	
K_{max} (Ness)	3.3 %	
K_{min} (Ness)	0.6 %	

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POROSITY

The porosity was calculated from a complex lithology model using density and neutron logs with the following matrix parameters.

	FDC	CNL
Quartz	2.65	-0.035
Heavy mineral	2.9	0.22
Fluid	1.03	1.0

The core porosity has not been corrected for the overburden effect.

WATER SATURATION

The water saturation was calculated from the North Sea equation:

$$\frac{1}{\sqrt{R_t}} = \left[\frac{V_{sh}^{c}}{\sqrt{R_{sh}}} + \frac{\emptyset^{m/2}}{\sqrt{aR_w}}\right] S_w^{n/2}$$

where R_t = true resistivity

R_w = formation water resistivity

S_w = water saturation

R_{sh} = shale resistivity

V_{sh} = shale volume

Ø = porosity

C = shale exponent (1.6)

m = cementation exponent (2.15)

n = saturation exponent (2.0)

a = lithology factor (0.62)

Since no laboratory results are available at the present time, standard values have been used for the parameters "m", "n" and "a".

CORE AND LOG DATA COMPARISONS

A set of crossplots were made in order to evaluate the relationship between the log and core parameters. Reduced linear regression was used.

The following relationships resulted:

Tarbert:

logKLH = 26.59 x PORHE -3.71
PHIF = 0.82 x PORHE +0.01

Ness:

logKLH = 21.98 x PORHE -2.66
PHIF = 1.10 x PORHE -0.04

Etive:

logKLH = 31.98 x PORHE -4.01
PHIF = 0.71 x PORHE +0.05

Rannoch:

logKLH = 19.88 x PORHE -2.88
PHIF = 1.08 x PORHE -0.02

KLH = horizontal permeability (core)
PORHE = helium porosity (core)
PHIF = final porosity (log)

<u>Comments:</u>

The relationships are fairly good for most of the crossplots. In a few crossplots it is, however, questionable whether it is justified to set up an equation for the relationship between the parameters (see especially the crossplot for PHIF versus PORHE in the Ness formation).

The core porosity/permeability data are not corrected for the overburden effect.

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CORING SUMMARY

A total of 23 cores were cut in the Brent formation. In order to compare with the logging depth the cores had to be shifted between -1.5 to +4 m. (The depths here indicated are drillers depth mRKB).

Coring results:

34/10-16

Core no.	Depth (mRKB)	Tot (m)	Rec (m)	Rec (%)	Core-log correction
1	3170.00-3177.00	7.00	5.35	76.4	+ 3.0
2	3177.00-3195.00	18.00	18.00	100.0	+ 1.25
3	3195.00-3213.00	18.00	16.80	93.3	+ 0.75
4	3213.00-3229.00	16.00	15.25	95.0	- 0.25
5	3229.00-3247.00	18.00	17.95	99.7	- 1.0
6	3247.00-3261.00	14.00	13.50	96.4	- 1.0
7	3261.00-3279.00	18.00	18.00	100.0	- 1.5
8	3280.00-3298.00	18.00	17.00	96.6	+ 3.0
9	3298.00-3311.00	13.00	10.00	77.0	+ 2.5
10	3311.00-3323.00	12.00	11.00	91.0	+ 1.5
11	3323.00-3341.40	18.40	18.40	100.0	+ 0.25
12	3341.40-3348.10	6.70	6.70	100.0	+ 0.5
13	3348.10-3359.00	11.00	8.00	73.0	+ 2.0
14	3359.00-3363.00	4.00	4.00	100.0	+ 1.0
15	3363.00-3369.00	6.00	6.00	100.0	+ 2.5
16	3369.00-3378.00	9.00	8.80	98.0	+ 2.75
17	3378.00-3387.00	9.00	9.00	100.0	+ 3.5
18	3387.00-3396.00	9.00	8.75	97.0	+ 3.5
19	3396.00-3414.00	18.00	17.40	97.0	+ 4.0
20	3414.00-3431.00	17.00	16.40	97.0	+ 3.0
21	3431.00-3450.00	19.00	17.00	89.0	+ 3.0
22	3450.00-3466.00	16.00	15.75	98.0	+ 2.0

APPENDIX

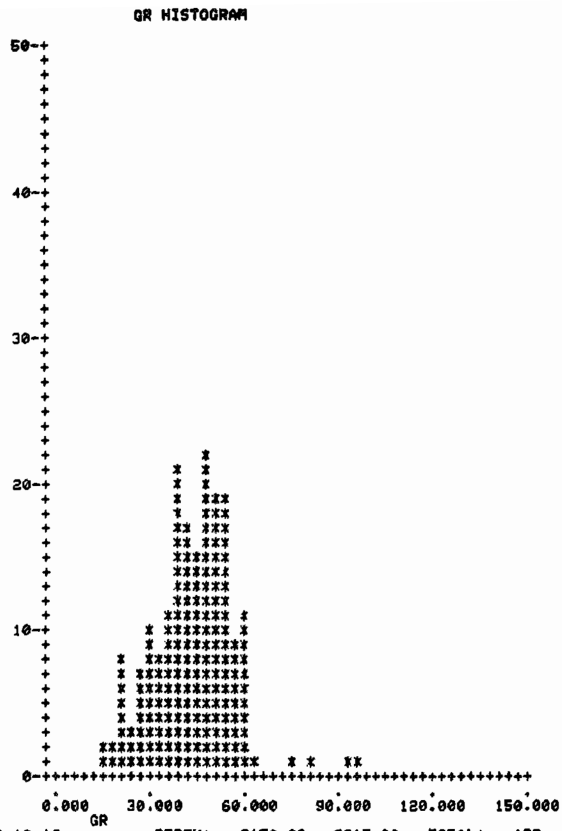
Histogram

Crossplots

Statistics

Quick look, thin sections

CPI



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X.AV: 45.3055

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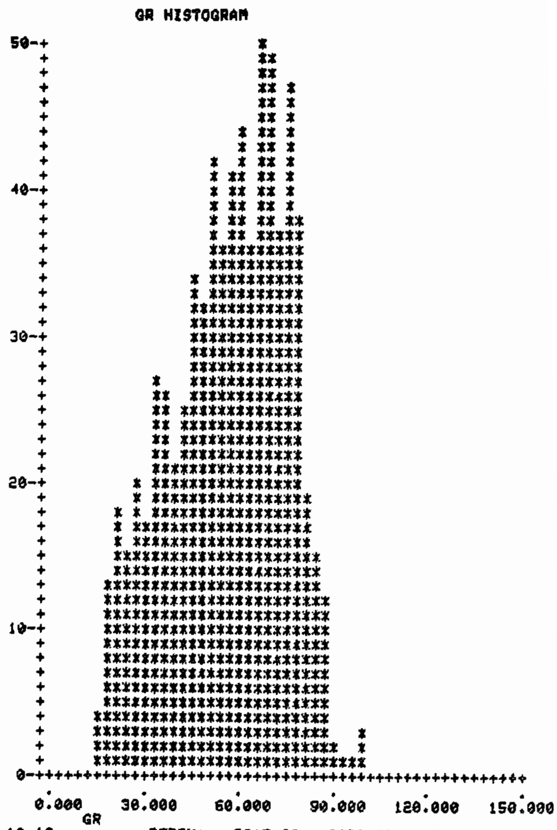

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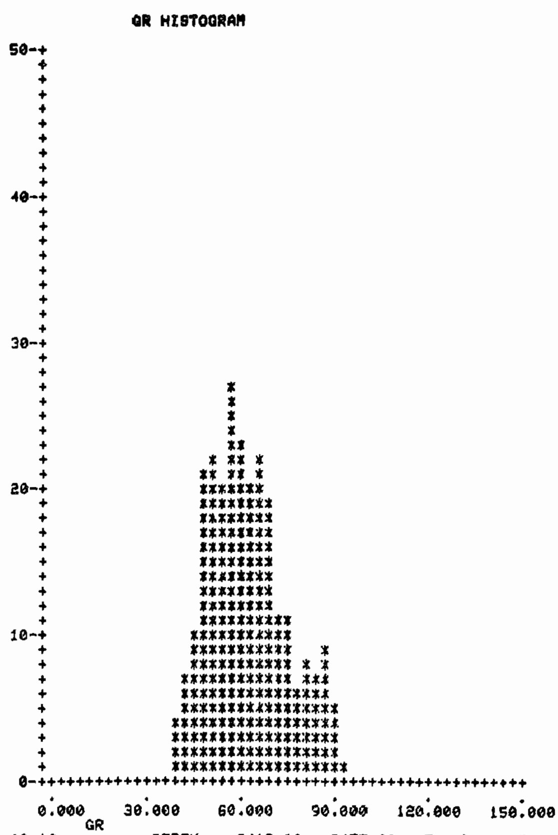

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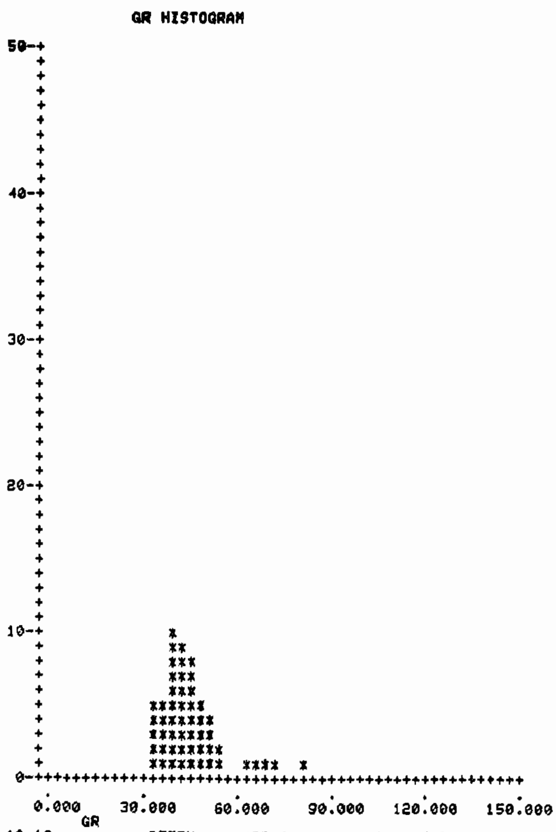
P L O T T E D B Y : BH



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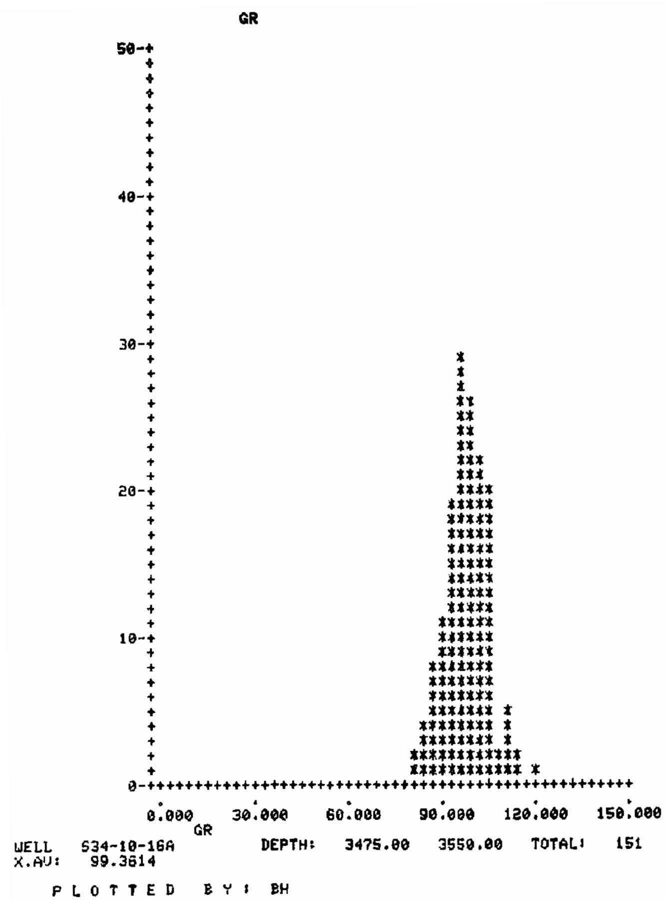
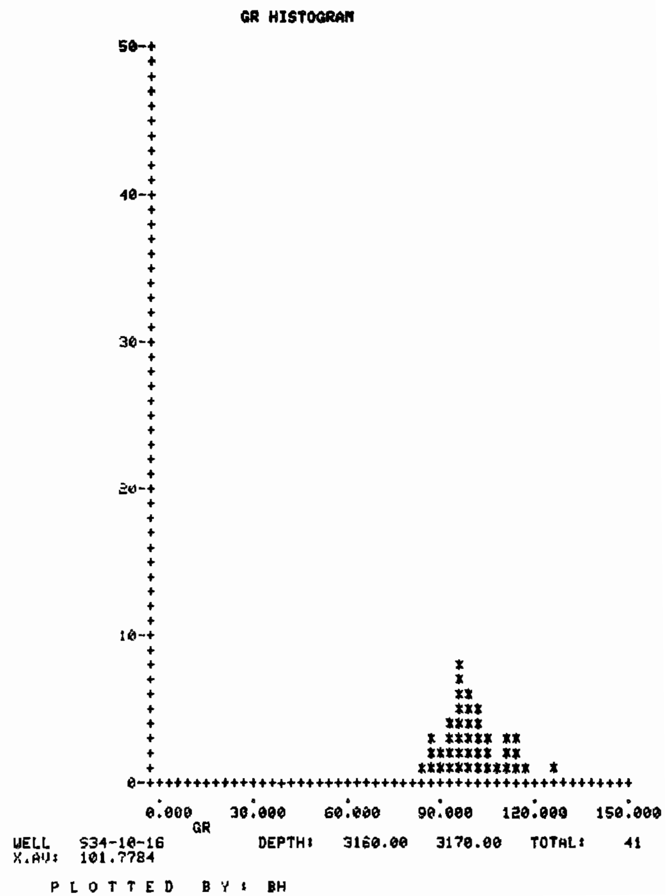
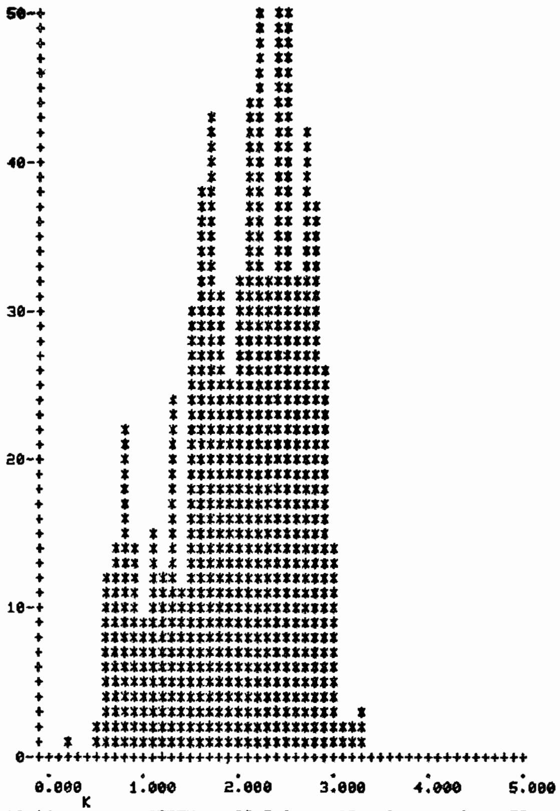
X.AV: 46.3949

P L O T T E D B Y : BH


GR
50
40
30
20
10
0
0.000
30.000
60.000
90.000
120.000
150.000
GR
WELL S34-10-16A
X.AV: 99.3614
DEPTH: 3475.00 3550.00 TOTAL: 151
PLOTTED BY: BH


GR HISTOGRAM
50
40
30
20
10
0
0.000
30.000
60.000
90.000
120.000
150.000
GR
WELL S34-10-16
X.AV: 101.7784
DEPTH: 3160.00 3170.00 TOTAL: 41
PLOTTED BY: BH

K HISTOGRAM



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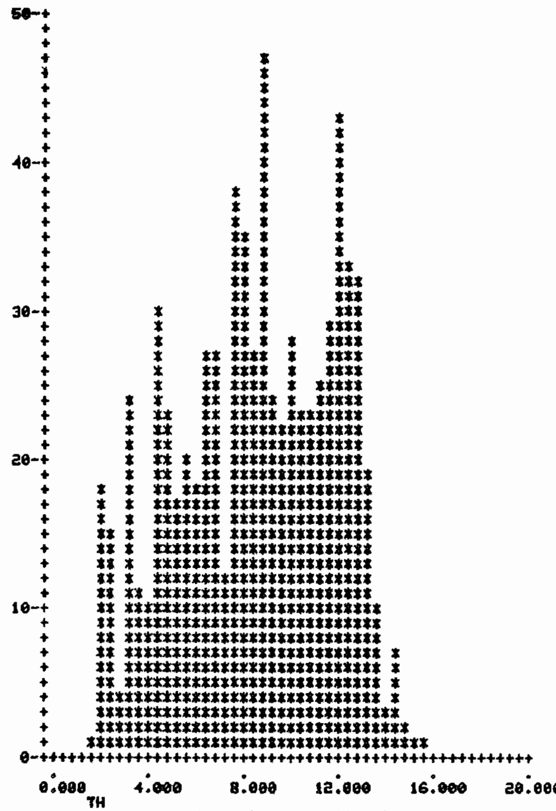
X.AV: 2.0627

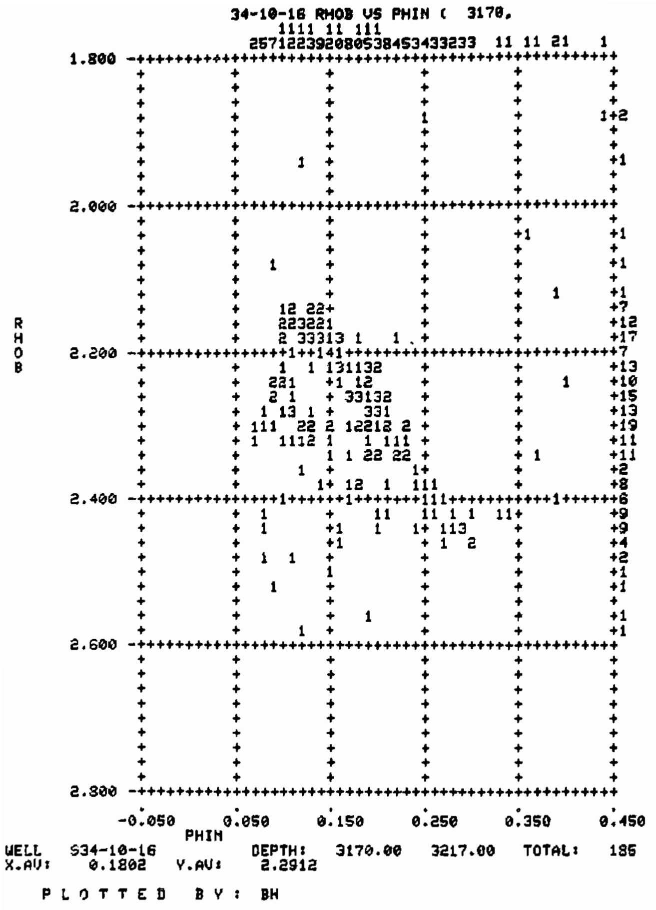
P L O T T E D B Y : BH

TH HISTOGRAM



WELL S34-10-16 DEPTH: 3217.00 3399.00 TOTAL: 729
X.AV: 8.6882

P L O T T E D B Y : BH


34-10-16 RHOB VS PHIN (3170,
RHOB
PHIN
-0.050 0.050 0.150 0.250 0.350 0.450
1.800 2.000 2.200 2.400 2.600 2.800
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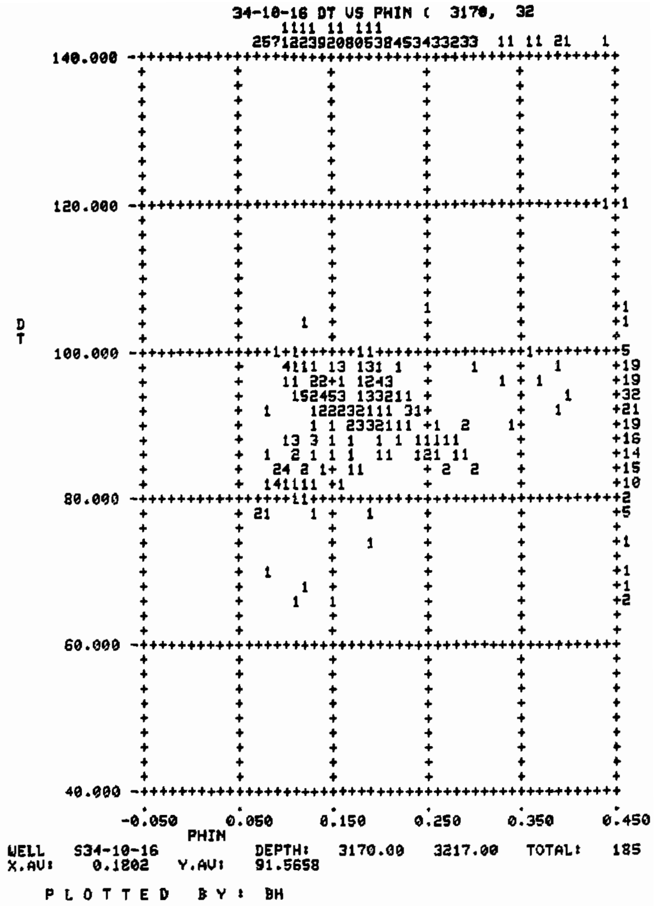
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DT
PHIN
-0.050 0.050 0.150 0.250 0.350 0.450
140.000 120.000 100.000 80.000 60.000 40.000
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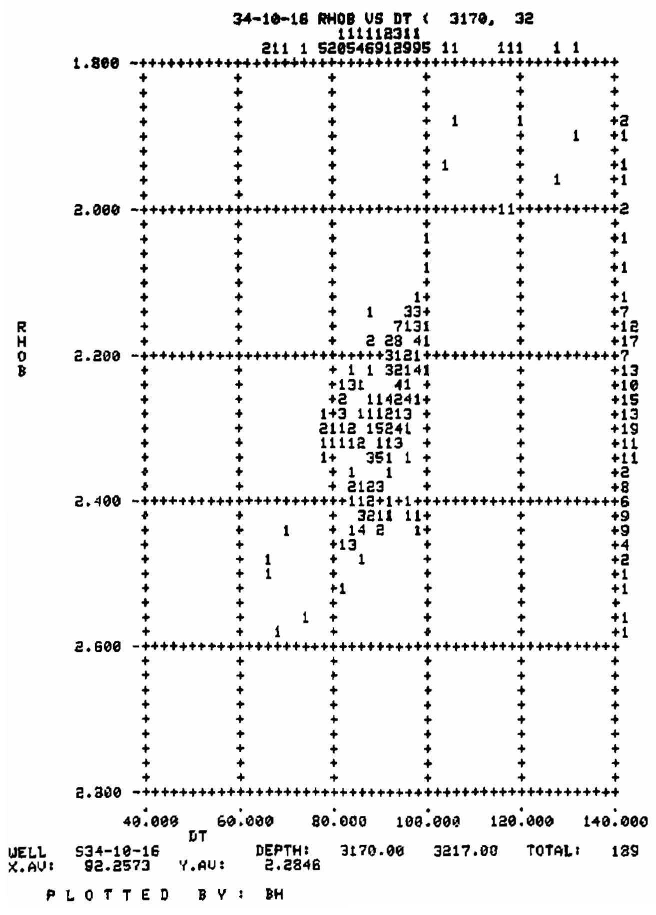
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RHOB
DT
40.000 60.000 80.000 100.000 120.000 140.000
1.800 2.000 2.200 2.400 2.600 2.800
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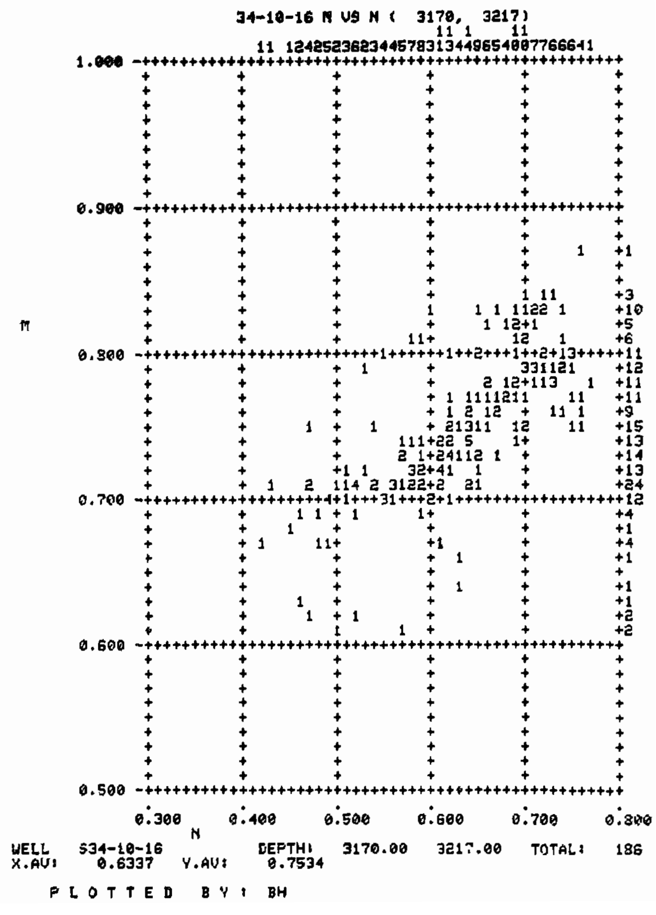
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M
N
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1.000 0.900 0.800 0.700 0.600 0.500
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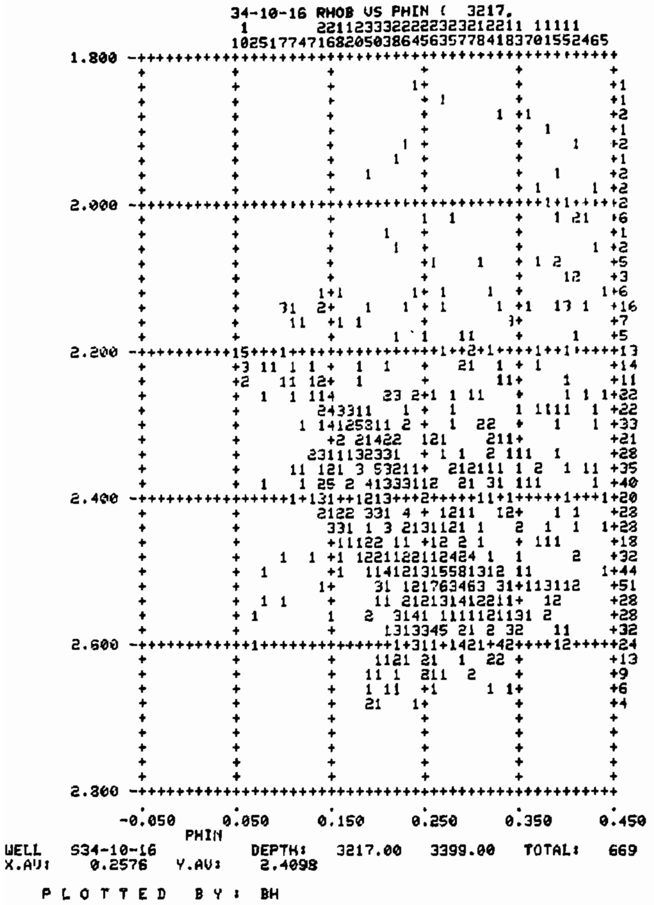
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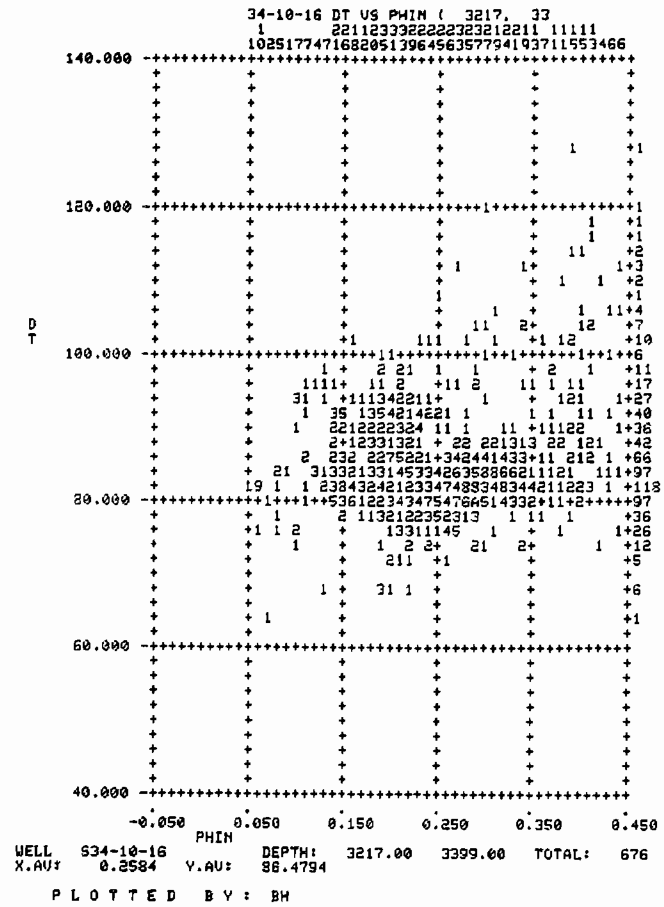
1.800
2.000
2.200
2.400
2.600
2.800
-0.050
0.050
0.150
0.250
0.350
0.450
PHIN
WELL S34-10-16 DEPTH: 3217.00 3399.00 TOTAL: 669
X.AV: 0.2576 Y.AV: 2.4098
P L O T T E D B Y : BH


34-10-16 DT VS PHIN (3217. 33
140.000
120.000
100.000
80.000
60.000
40.000
DT
-0.050
0.050
0.150
0.250
0.350
0.450
PHIN
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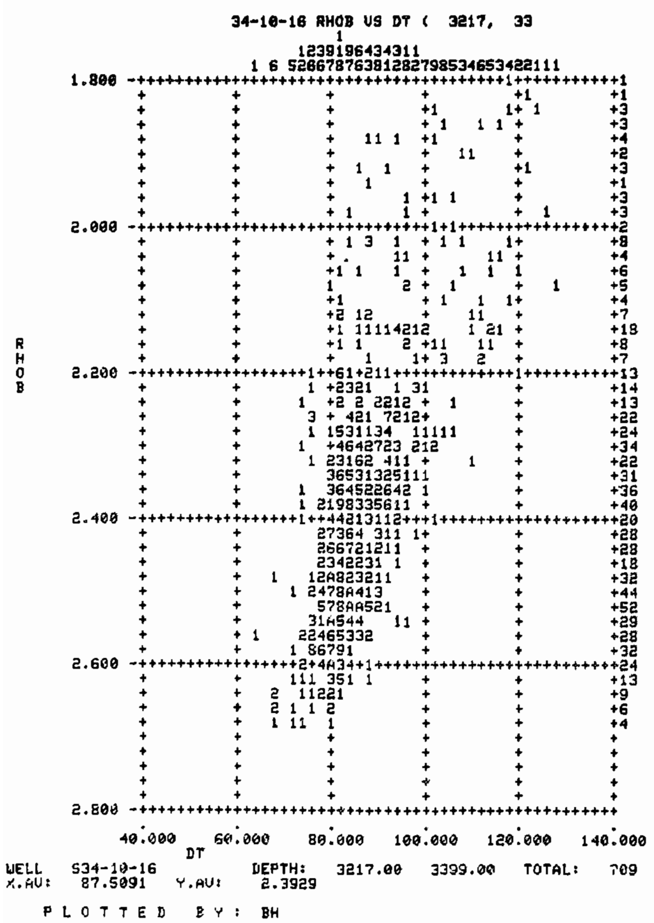
P L O T T E D B Y : BH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1.800
2.000
2.200
2.400
2.600
2.800
RHOB
40.000
60.000
80.000
100.000
120.000
140.000
DT
WELL S34-10-16 DEPTH: 3217.00 3399.00 TOTAL: 709
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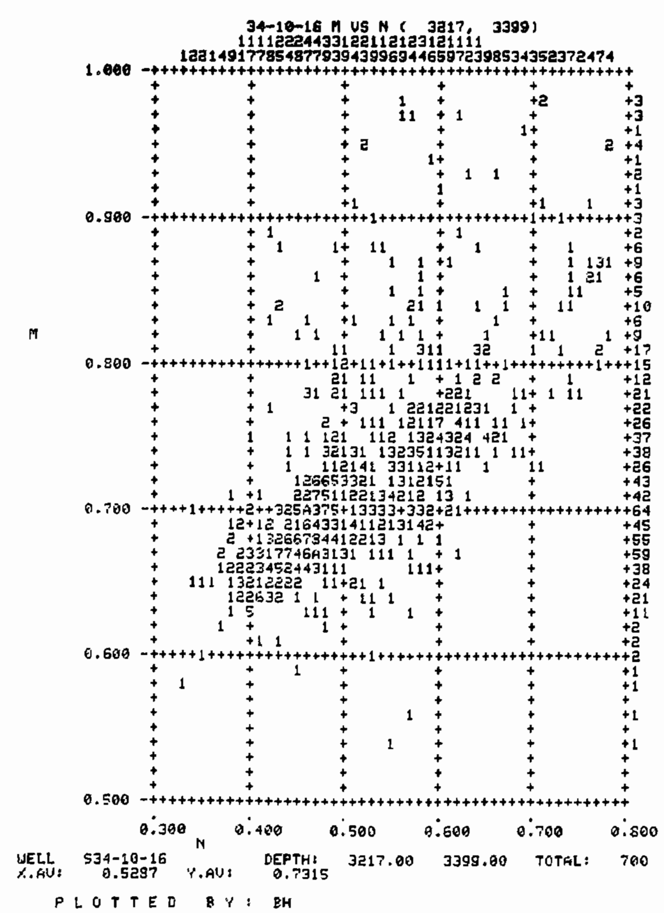
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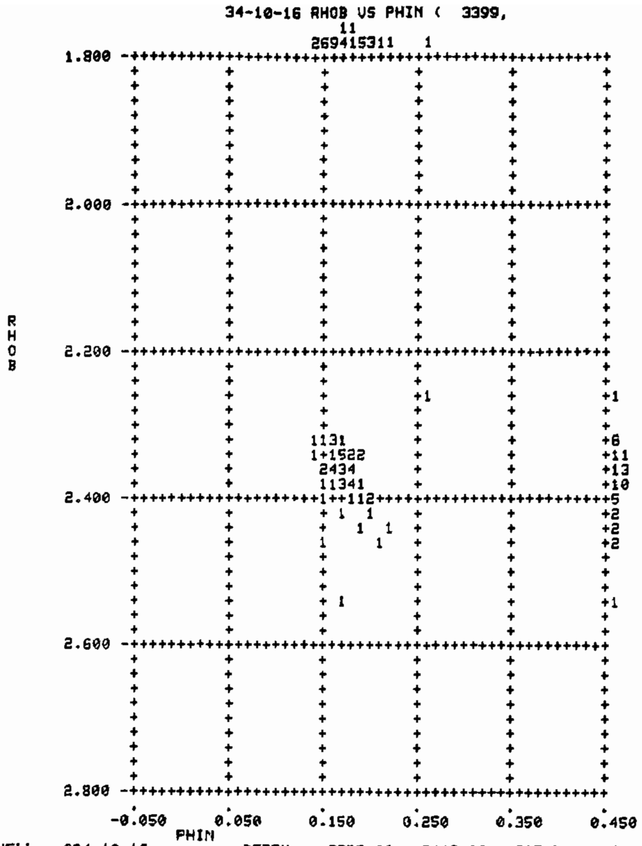
0.900
0.800
0.700
0.600
0.500
M
0.300
0.400
0.500
0.600
0.700
0.800
N
WELL S34-10-16 DEPTH: 3217.00 3399.00 TOTAL: 700
X.AV: 0.5287 Y.AV: 0.7315
P L O T T E D B Y : BH

34-10-16 RHOB VS PHIN (3399,



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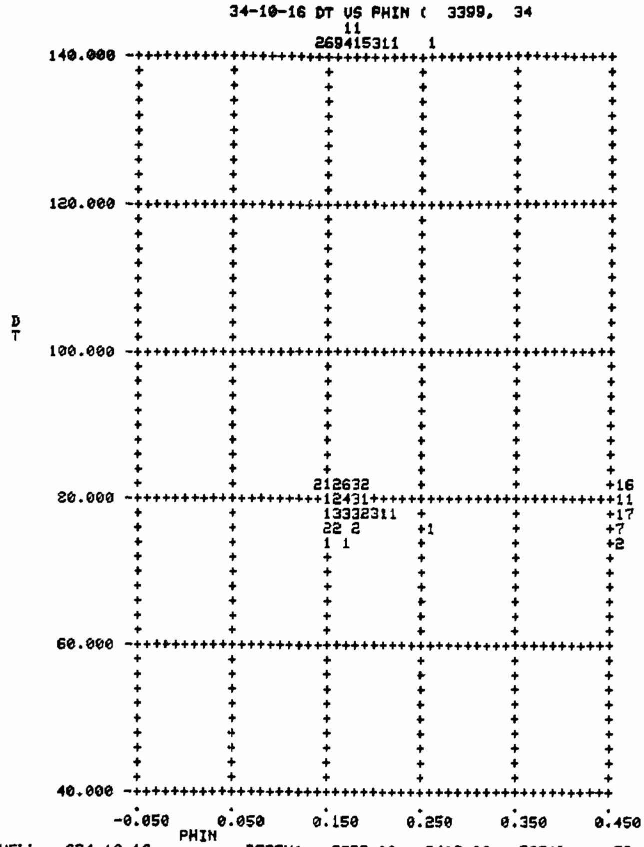
PLOTTED BY: BH

34-10-16 DT VS PHIN (3399, 34



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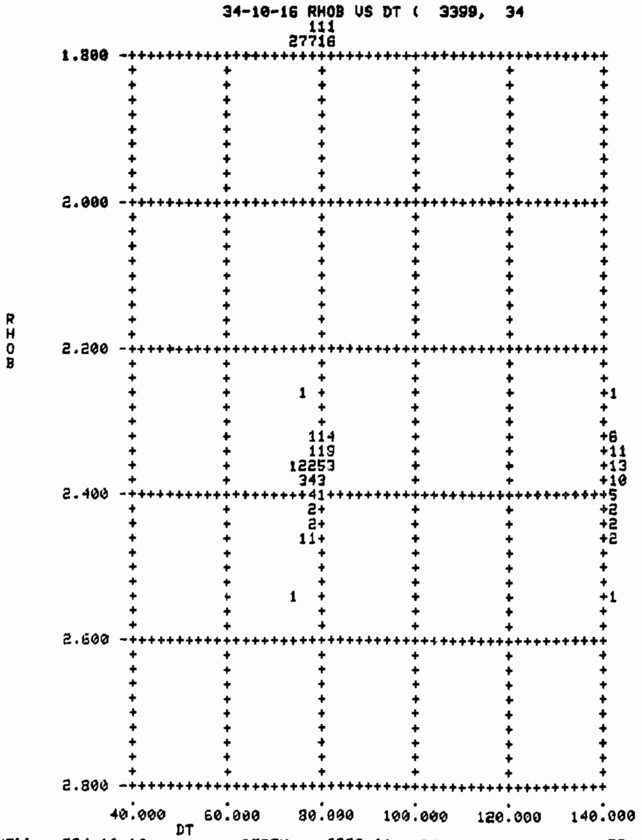
PLOTTED BY: BH

34-10-16 RHOB VS DT (3399, 34



WELL S34-10-16 DEPTH: 3399.00 3412.00 TOTAL: 53
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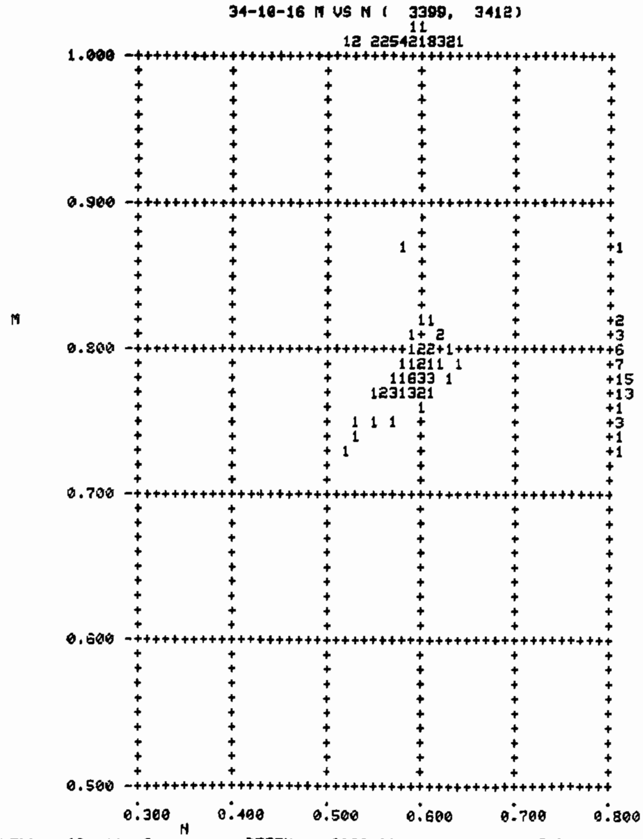
PLOTTED BY: BH

34-10-16 M VS N (3399, 3412)



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PLOTTED BY: BH

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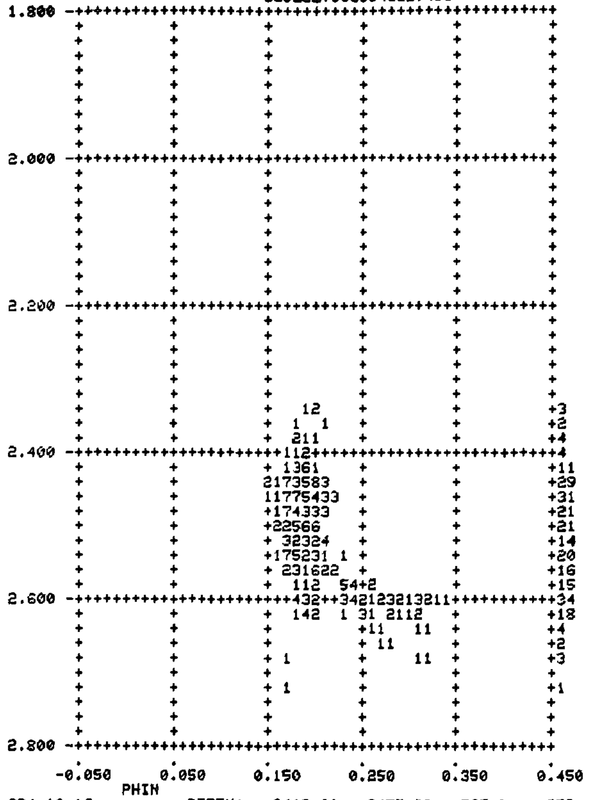
3692327508554632741 1



WELL S34-10-16 DEPTH: 3412.00 3475.00 TOTAL: 253
X.AV: 0.2104 Y.AV: 2.5274

P L O T T E D B Y : BH

34-10-16 DT VS PHIN (3412, 34
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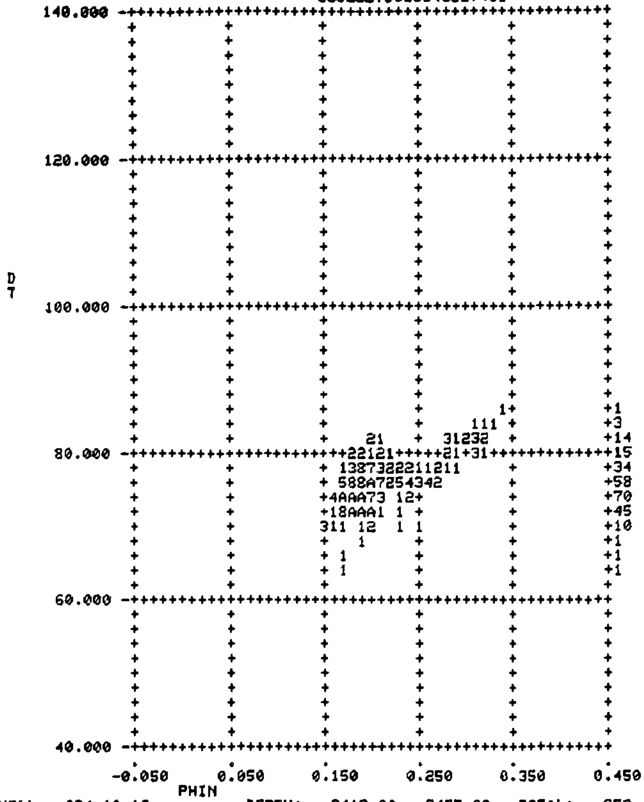
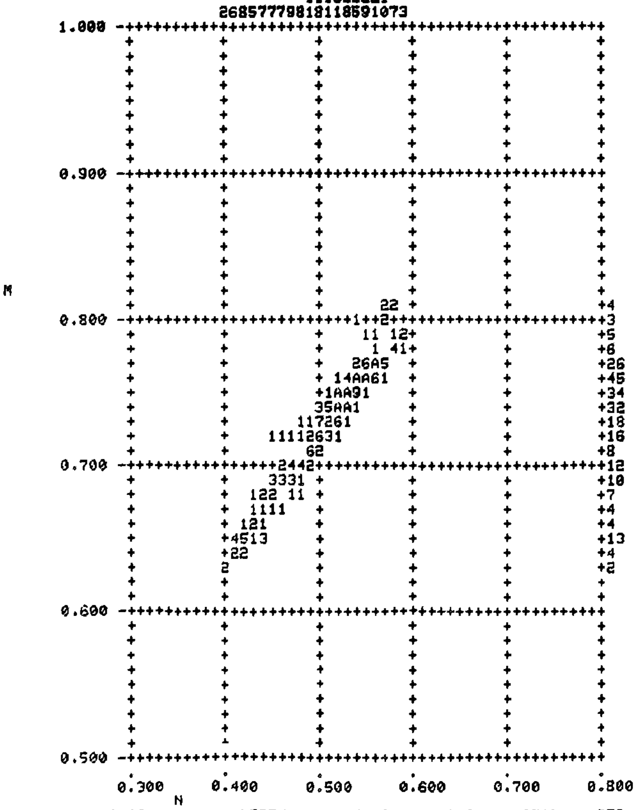
3692327508554632741 1



WELL S34-10-16 DEPTH: 3412.00 3475.00 TOTAL: 253
X.AV: 0.2104 Y.AV: 76.4022

P L O T T E D B Y : BH

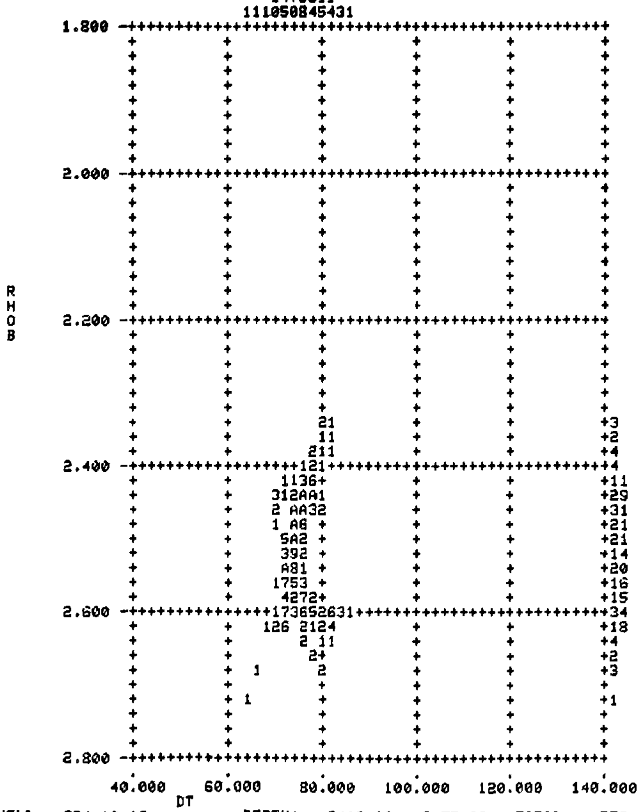
34-10-16 M VS N (3412, 3475)
111322221
2685777981811859 1073



WELL S34-10-16 DEPTH: 3412.00 3475.00 TOTAL: 253
X.AV: 0.5189 Y.AV: 0.7388

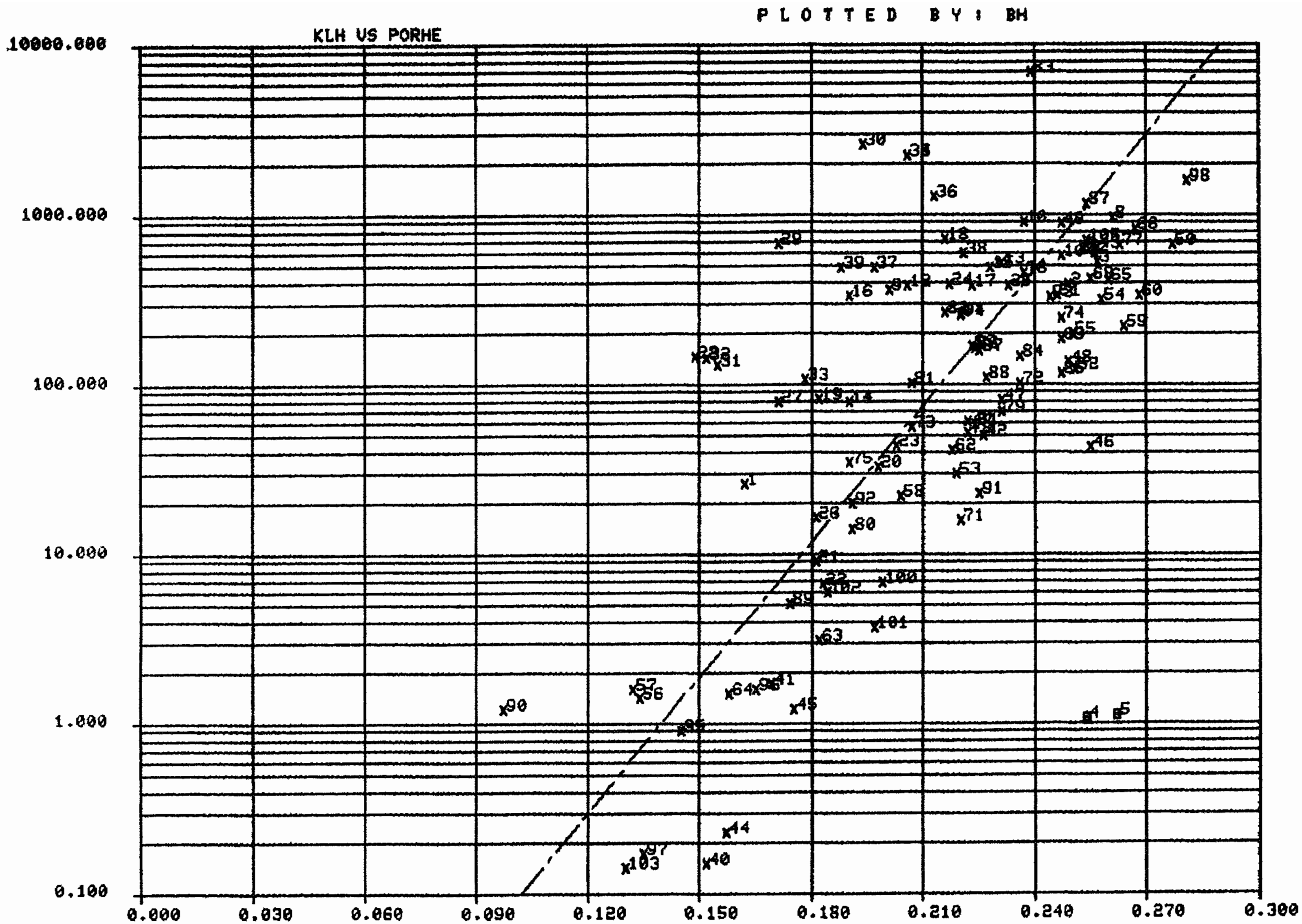
P L O T T E D B Y : BH

34-10-16 RHOB VS DT (3412, 34
1475311
111050845431



WELL S34-10-16 DEPTH: 3412.00 3475.00 TOTAL: 253
X.AV: 76.4022 Y.AV: 2.5274

P L O T T E D B Y : BH



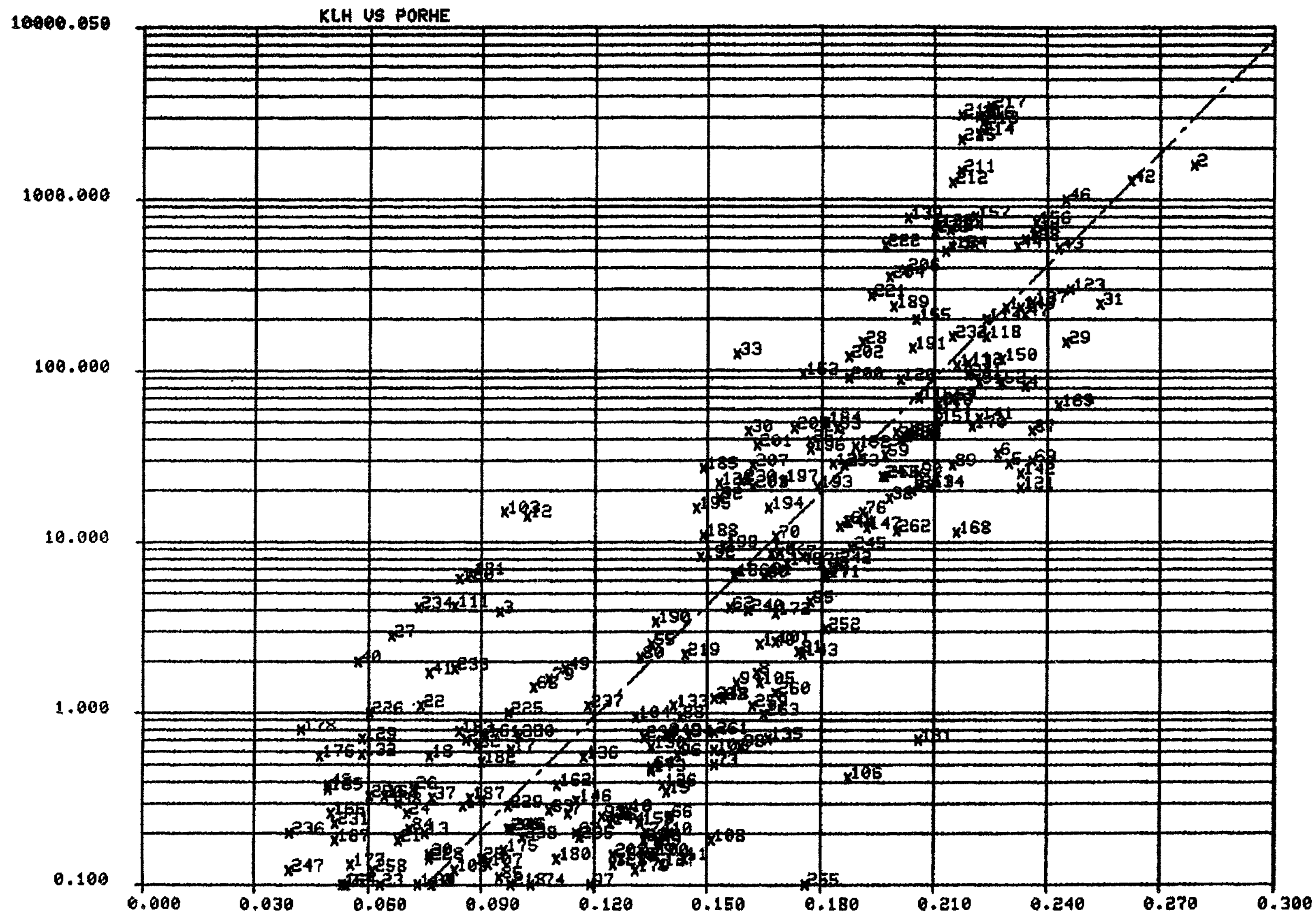
Log(Y)=A*X+B

A= 26.59081675 B= -3.71004271 C2= 0.50641166

DO YOU WANT TO DELETE ANY POINTS?
NO

DO YOU WANT TO ADD ANY POINTS?
NO

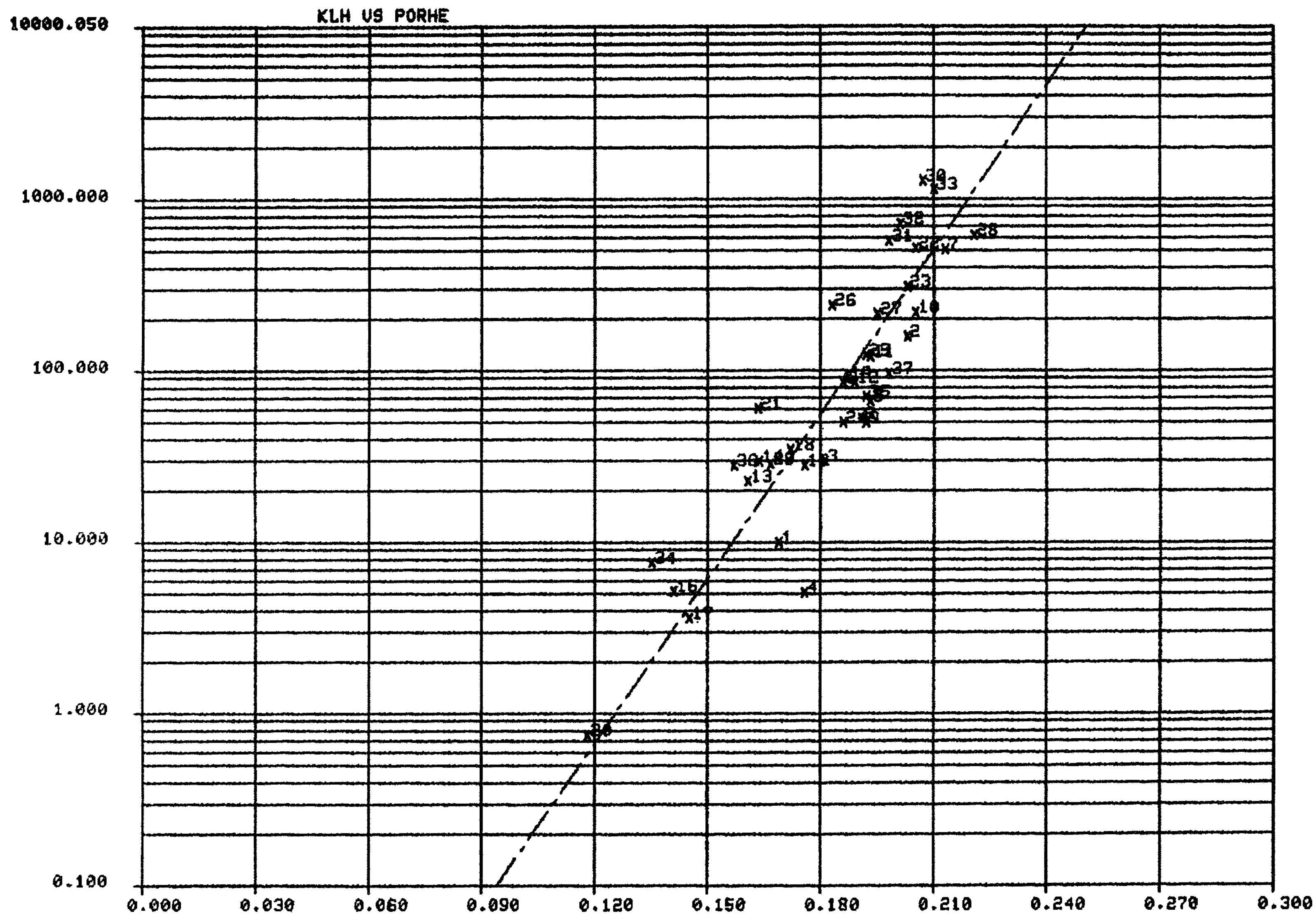
WELL 534-10-16 DEPTH: 3171.00 3217.00 TOTAL: 103 X.AV: 0.2121 Y.AV: 393.5630



Log(Y)=A*X+B
A= 21.97916781 B= -2.65762437 C2= 0.67041769
DO YOU WANT TO DELETE ANY POINTS?
NO

WELL S34-10-16 DEPTH: 3217.00 3399.00 TOTAL: 263 X.AV: 0.1538 Y.AV: 148.4330

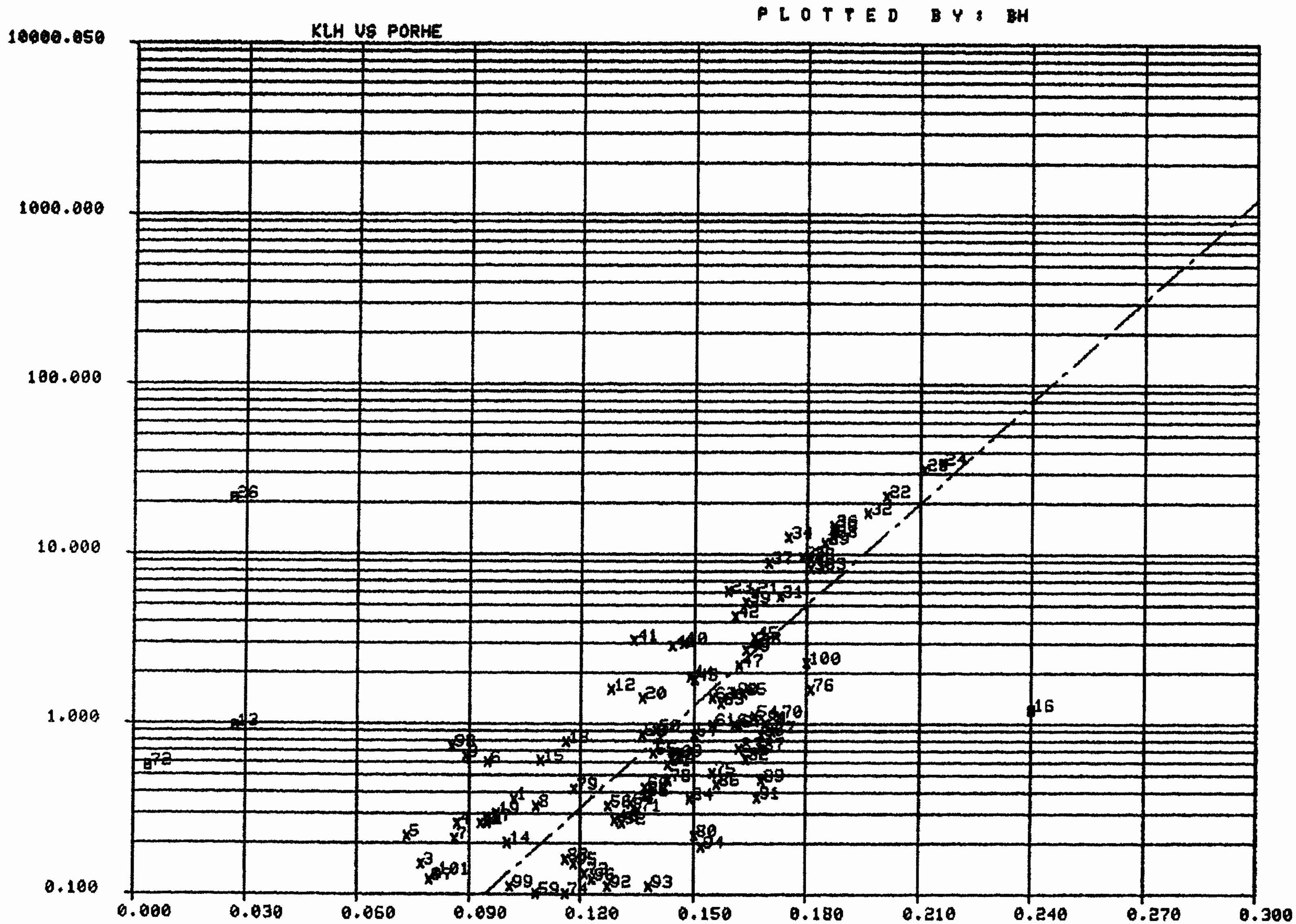
P L O T T E D B Y : BH



Log(Y)=A*X+B
A= 31.98304459 B= -4.00583712 C2= 0.80100872
DO YOU WANT TO DELETE ANY POINTS?
NO

WELL S34-10-16 DEPTH: 3399.00 3412.00 TOTAL: 37 X.AV: 0.1829 Y.AV: 207.8176

P L O T T E D B Y : BH



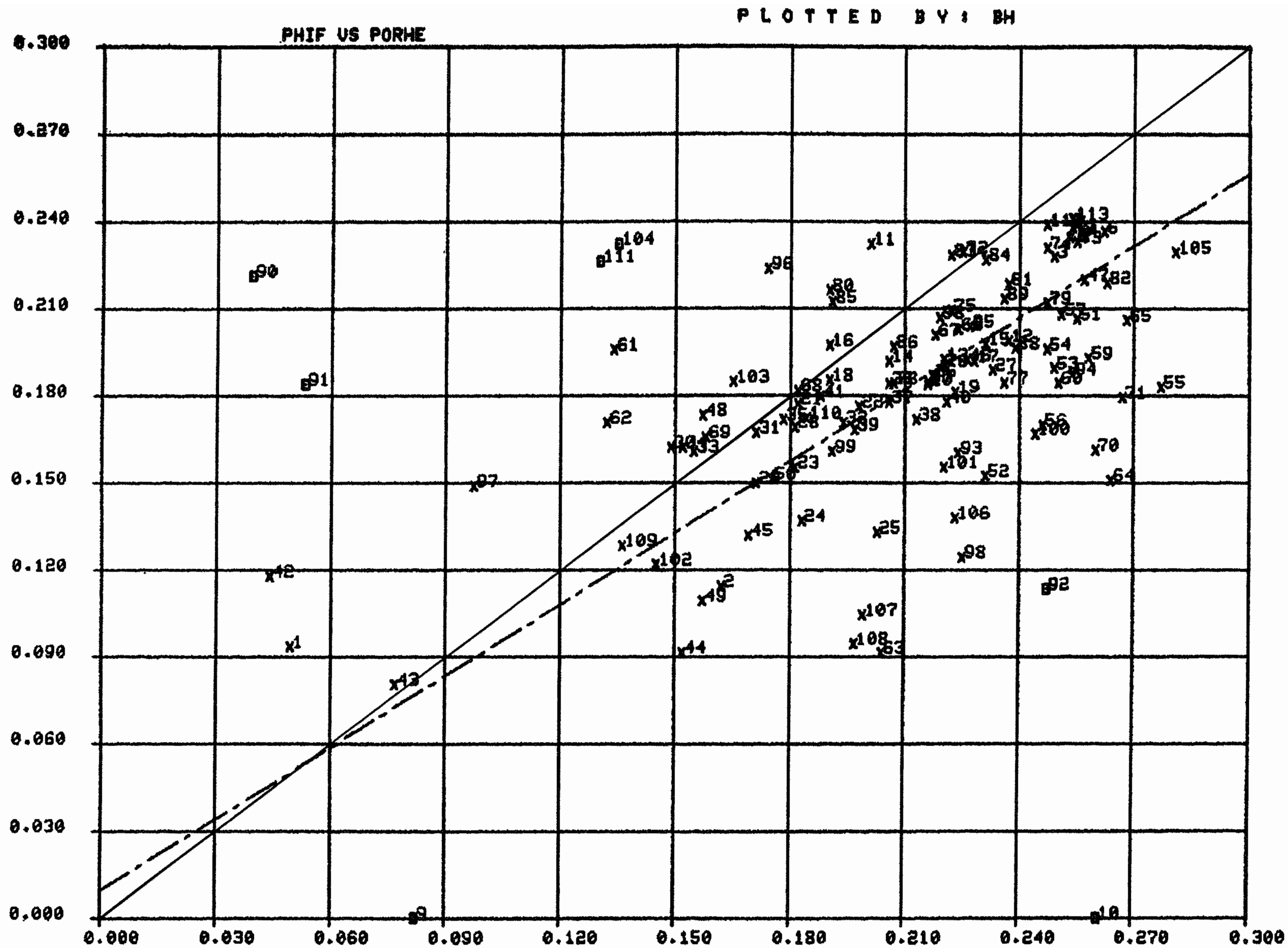
Log(Y)=A*X+B

A= 19.87932766 B= -2.87562820 C2= 0.60754105

DO YOU WANT TO DELETE ANY POINTS?
NO

DO YOU WANT TO ADD ANY POINTS?
NO

WELL S34-10-16 DEPTH: 3412.00 3475.00 TOTAL: 97 X.AV: 0.1438 Y.AV: 3.1707



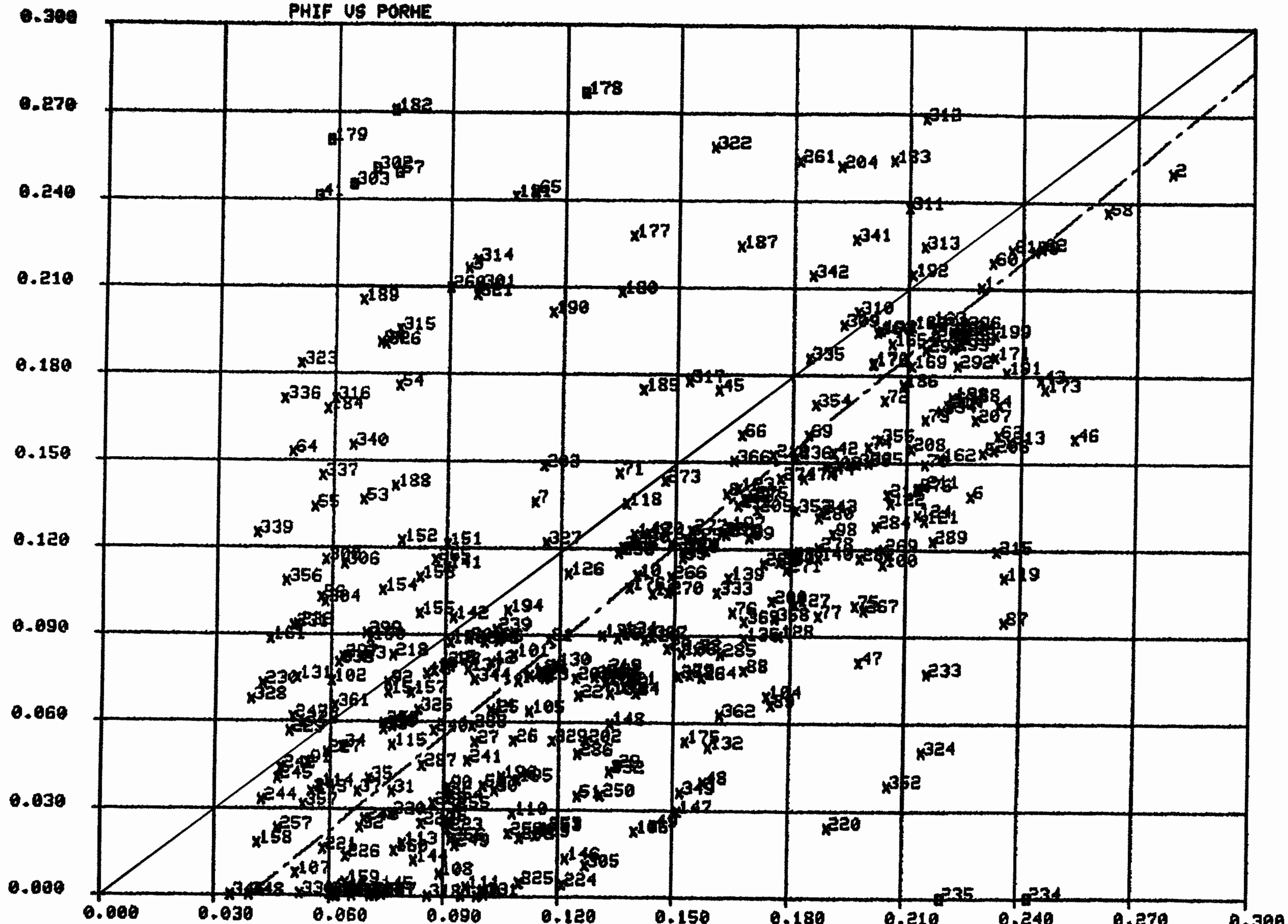
Y=A*X+B

A= 0.82336394 B= 0.00935200 C2= 0.39021902

DO YOU WANT TO DELETE ANY POINTS?
NO

DO YOU WANT TO ADD ANY POINTS?
NO

WELL S34-10-16 DEPTH: 3171.00 3217.00 TOTAL: 106 X.AV: 0.2080 Y.AV: 0.1806



A= 1.09675441 B= -0.04333650 C2= 0.34831038

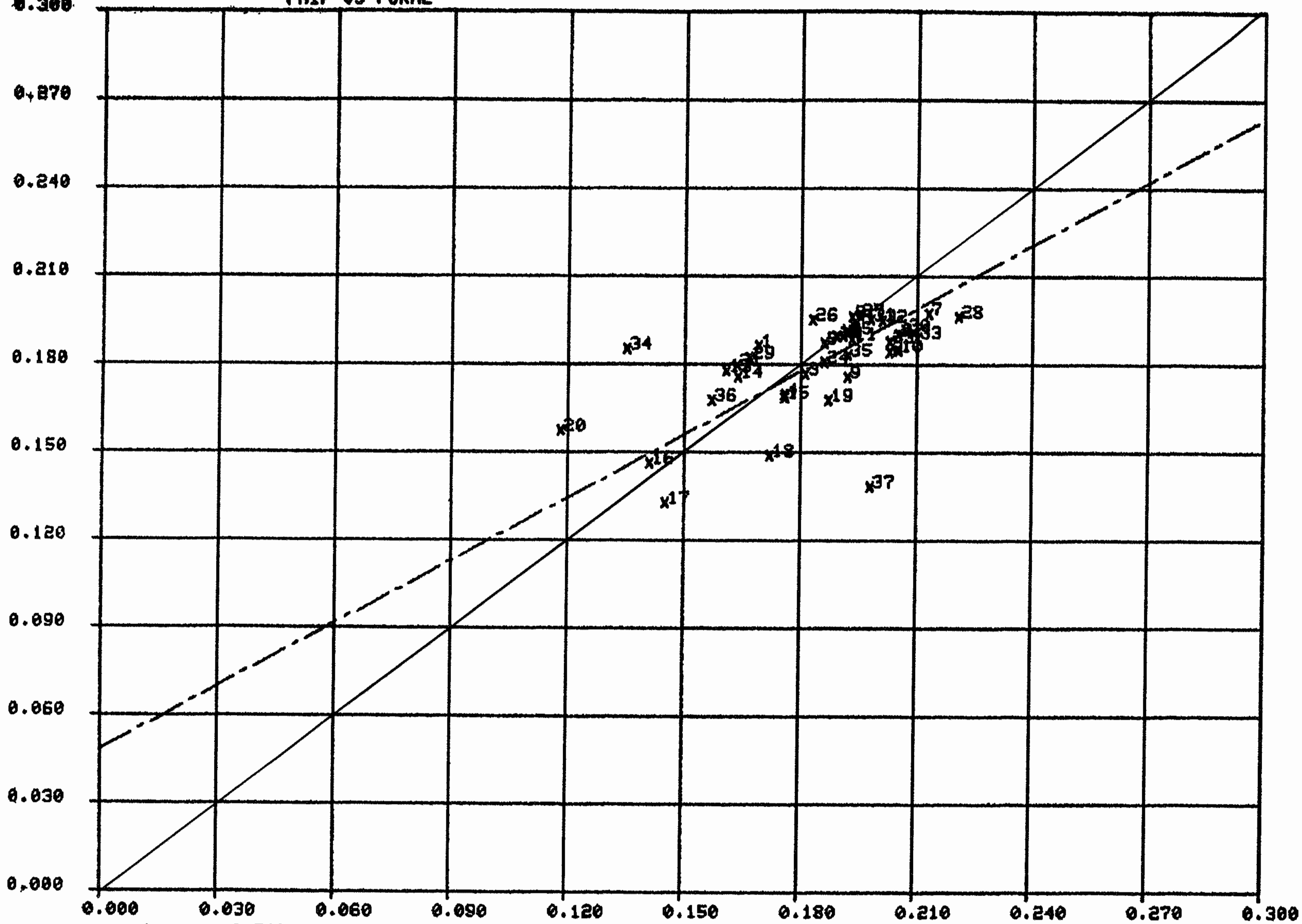
DO YOU WANT TO DELETE ANY POINTS?
NO

DO YOU WANT TO ADD ANY POINTS?
NO

WELL S34-10-16 DEPTH: 3217.00 3399.00 TOTAL: 357 X.AV: 0.1359 Y.AV: 0.1057

P L O T T E D B Y : BH

PHIF VS PORHE

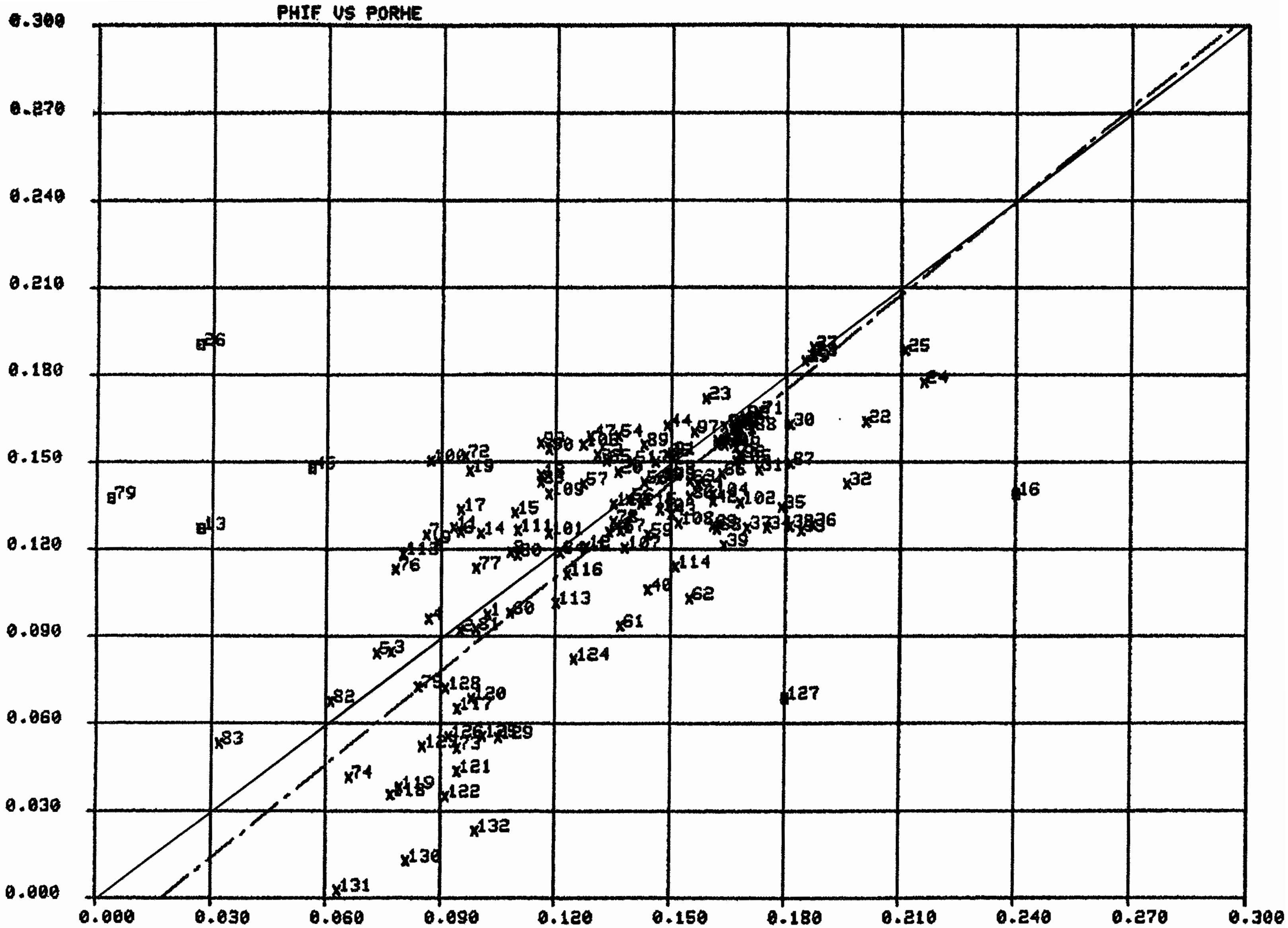


A= 0.71862407 B= 0.04846102 C2= 0.33650371

DO YOU WANT TO DELETE ANY POINTS?
NO

WELL S34-10-16 DEPTH: 3399.00 3412.00 TOTAL: 37 X.AV: 0.1829 Y.AV: 0.1799

P L O T T E D B Y : BH



A= 1.07607509 B= -0.01847679 C2= 0.52929207

DO YOU WANT TO DELETE ANY POINTS?
NO

DO YOU WANT TO ADD ANY POINTS?
NO

WELL 634-10-16 DEPTH: 3412.00 3475.00 TOTAL: 126 X.AV: 0.1326 Y.AV: 0.1242

P L O T T E D B Y : BH

```
 S T A T I S T I C S
*********************

FIELD: . . . . . . . . . . .         34/10 ALPHA
WELL:  . . . . . . . . . . .            34-10-16
ENGINEER:  . . . . . . . . . BH
DATE:  . . . . .             15.49   30 SEP 1983

DEPTH INTERVAL:  . . .  3171.00 TO  3475.00
APPLIED CUTOFFS:
.              VSH:  GREATER THAN       0.40
.             PHIF:     LESS THAN       0.10
.               SW:  GREATER THAN       0.65


 T O T A L   D E P T H
*****************************************
THICKNESS: . . . . . . . . .    304.000
AVERAGE  . . . 'PHIF'  . . .      0.126
AVERAGE  . . . 'VSHALE'  . .      0.305
AVERAGE  . . . 'SW'  . . . .      0.535
W.AVERAGE  . . 'SW' * 'PHIF'      0.410
AVERAGE  . . . 'SH'  . . . .      0.467
VOID VOLUME: . . . ('PHIF').     38.163
HC VOID VOLUME . . ('SH'*) .     22.717
RES HC VOID VOLUME ('SHR'*).      7.995
MOV HC VOID VOLUME . . . . .     14.723
*****************************************


 N E T   P A Y
*****************************************
THICKNESS: . . . . . . . . .    114.500
AVERAGE  . . . 'PHIF'  . . .      0.177
AVERAGE  . . . 'VSHALE'  . .      0.124
AVERAGE  . . . 'SW'  . . . .      0.269
W.AVERAGE  . . 'SW' * 'PHIF'      0.247
AVERAGE  . . . 'SH'  . . . .      0.731
VOID VOLUME: . . . ('PHIF').     20.271
HC VOID VOLUME . . ('SH'*) .     15.264
RES HC VOID VOLUME ('SHR'*).      6.386
MOV HC VOID VOLUME . . . . .      8.878
*****************************************


 N E T   S A N D
*****************************************
THICKNESS: . . . . . . . . .    151.500
AVERAGE  . . . 'PHIF'  . . .      0.169
AVERAGE  . . . 'VSHALE'  . .      0.115
AVERAGE  . . . 'SW'  . . . .      0.410
W.AVERAGE  . . 'SW' * 'PHIF'      0.369
AVERAGE  . . . 'SH'  . . . .      0.593
VOID VOLUME: . . . ('PHIF').     25.570
HC VOID VOLUME . . ('SH'*) .     16.164
RES HC VOID VOLUME ('SHR'*).      6.544
MOV HC VOID VOLUME . . . . .      9.620
*****************************************


 N E T / G R O S S   R A T I O S
****************************************

HNETPAY /HGROSS SAND =  0.37664
HNETSAND/HGROSS SAND =  0.49836
HNETPAY /HNETSAND    =  0.75578
****************************************
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```
 S T A T I S T I C S
*********************

FIELD: . . . . . . . . . . .             ALPHA
WELL:  . . . . . . . . . . .          34-10-16
ENGINEER:  . . . . . . . . . BH
DATE:  . . . . .             11.41   30 SEP 1983

DEPTH INTERVAL:  . . .  3171.00 TO  3217.00
APPLIED CUTOFFS:
.              VSH:  GREATER THAN       0.40
.             PHIF:     LESS THAN       0.10
.               SW:  GREATER THAN       0.65


 T O T A L    D E P T H
******************************************
THICKNESS: . . . . . . . . .        46.000
AVERAGE   . . . 'PHIF'  . . .        0.178
AVERAGE   . . . 'VSHALE'  . .        0.124
AVERAGE   . . . 'SW'   . . . .       0.198
W.AVERAGE  . . 'SW' * 'PHIF'         0.160
AVERAGE   . . . 'SH'   . . . .       0.800
VOID VOLUME: . . . ('PHIF').         8.199
HC VOID VOLUME . . ('SH'*) .         6.887
RES HC VOID VOLUME ('SHR'*).         3.408
MOV HC VOID VOLUME . . . . .         3.479
******************************************


 N E T    P A Y
******************************************
THICKNESS: . . . . . . . . .        40.250
AVERAGE   . . . 'PHIF'  . . .        0.191
AVERAGE   . . . 'VSHALE'  . .        0.089
AVERAGE   . . . 'SW'   . . . .       0.158
W.AVERAGE  . . 'SW' * 'PHIF'         0.149
AVERAGE   . . . 'SH'   . . . .       0.842
VOID VOLUME: . . . ('PHIF').         7.668
HC VOID VOLUME . . ('SH'*) .         6.527
RES HC VOID VOLUME ('SHR'*).         3.263
MOV HC VOID VOLUME . . . . .         3.264
******************************************


 N E T   S A N D
******************************************
THICKNESS: . . . . . . . . .        40.500
AVERAGE   . . . 'PHIF'  . . .        0.190
AVERAGE   . . . 'VSHALE'  . .        0.091
AVERAGE   . . . 'SW'   . . . .       0.181
W.AVERAGE  . . 'SW' * 'PHIF'         0.151
AVERAGE   . . . 'SH'   . . . .       0.839
VOID VOLUME: . . . ('PHIF').         7.699
HC VOID VOLUME . . ('SH'*) .         6.537
RES HC VOID VOLUME ('SHR'*).         3.263
MOV HC VOID VOLUME . . . . .         3.274
******************************************


 N E T / G R O S S    R A T I O S
*****************************************

HNETPAY /HGROSS SAND =   0.87500
HNETSAND/HGROSS SAND =   0.88043
HNETPAY /HNETSAND    =   0.99383
*****************************************
```

```
 S T A T I S T I C S
*********************

FIELD: . . . . . . . . . . .               34-10-16
WELL:  . . . . . . . . . . .               34-10-16
ENGINEER:  . . . . . . . . . BH
DATE:  . . . . .                17.20    26 SEP 1983

DEPTH INTERVAL:  . . .  3217.00 TO  3399.00
APPLIED CUTOFFS:
.              VSH:  GREATER THAN       0.40
.             PHIF:     LESS THAN       0.10
.               SW:  GREATER THAN       0.65


 T O T A L   D E P T H
******************************************
THICKNESS: . . . . . . . . .     182.000
AVERAGE   . . . 'PHIF'  . . .      0.113
AVERAGE   . . . 'VSHALE'  . .      0.418
AVERAGE   . . . 'SW'   . . . .     0.524
W.AVERAGE  . . 'SW' * 'PHIF'       0.385
AVERAGE   . . . 'SH'   . . . .     0.463
VOID VOLUME: . . . ('PHIF').      20.520
HC VOID VOLUME . . ('SH'*) .      12.692
RES HC VOID VOLUME ('SHR'*).       3.515
MOV HC VOID VOLUME . . . . .       9.177
******************************************


 N E T    P A Y
******************************************
THICKNESS: . . . . . . . . .      53.750
AVERAGE   . . . 'PHIF'  . . .      0.173
AVERAGE   . . . 'VSHALE'  . .      0.188
AVERAGE   . . . 'SW'   . . . .     0.306
W.AVERAGE  . . 'SW' * 'PHIF'       0.284
AVERAGE   . . . 'SH'   . . . .     0.694
VOID VOLUME: . . . ('PHIF').       9.309
HC VOID VOLUME . . ('SH'*) .       6.667
RES HC VOID VOLUME ('SHR'*).       2.276
MOV HC VOID VOLUME . . . . .       4.391
******************************************


 N E T   S A N D
******************************************
THICKNESS: . . . . . . . . .      55.250
AVERAGE   . . . 'PHIF'  . . .      0.172
AVERAGE   . . . 'VSHALE'  . .      0.190
AVERAGE   . . . 'SW'   . . . .     0.317
W.AVERAGE  . . 'SW' * 'PHIF'       0.292
AVERAGE   . . . 'SH'   . . . .     0.683
VOID VOLUME: . . . ('PHIF').       9.481
HC VOID VOLUME . . ('SH'*) .       6.717
RES HC VOID VOLUME ('SHR'*).       2.281
MOV HC VOID VOLUME . . . . .       4.436
******************************************


 N E T / G R O S S    R A T I O S
*****************************************

HNETPAY /HGROSS SAND =   0.29533
HNETSAND/HGROSS SAND =   0.30357
HNETPAY /HNETSAND    =   0.97285
*****************************************
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 S T A T I S T I C S
*********************

FIELD: . . . . . . . . . . .        34/10-ALPHA
WELL:  . . . . . . . . . . .           34-10-16
ENGINEER:  . . . . . . . . . BH
DATE:   . . . . .            16.48   14 SEP 1983

DEPTH INTERVAL:  . . .  3399.00 TO  3412.00
APPLIED CUTOFFS:
.              USH:  GREATER THAN       0.40
.             PHIF:     LESS THAN       0.10
.               SW:  GREATER THAN       0.65


 T O T A L   D E P T H
******************************************
THICKNESS: . . . . . . . . .      13.000
AVERAGE  . . . 'PHIF'  . . .       0.180
AVERAGE  . . . 'VSHALE'  . .       0.032
AVERAGE  . . . 'SW'  . . . .       0.301
W.AVERAGE  . . 'SW' * 'PHIF'       0.297
AVERAGE  . . . 'SH'  . . . .       0.699
VOID VOLUME: . . . ('PHIF').       2.344
HC VOID VOLUME . . ('SH'*) .       1.648
RES HC VOID VOLUME ('SHR'*).       0.678
MOV HC VOID VOLUME . . . . .       0.969
******************************************


 N E T    P A Y
******************************************
THICKNESS: . . . . . . . . .      13.000
AVERAGE  . . . 'PHIF'  . . .       0.180
AVERAGE  . . . 'VSHALE'  . .       0.032
AVERAGE  . . . 'SW'  . . . .       0.301
W.AVERAGE  . . 'SW' * 'PHIF'       0.297
AVERAGE  . . . 'SH'  . . . .       0.699
VOID VOLUME: . . . ('PHIF').       2.344
HC VOID VOLUME . . ('SH'*) .       1.648
RES HC VOID VOLUME ('SHR'*).       0.678
MOV HC VOID VOLUME . . . . .       0.969
******************************************


 N E T    S A N D
******************************************
THICKNESS: . . . . . . . . .      13.000
AVERAGE  . . . 'PHIF'  . . .       0.180
AVERAGE  . . . 'VSHALE'  . .       0.032
AVERAGE  . . . 'SW'  . . . .       0.301
W.AVERAGE  . . 'SW' * 'PHIF'       0.297
AVERAGE  . . . 'SH'  . . . .       0.699
VOID VOLUME: . . . ('PHIF').       2.344
HC VOID VOLUME . . ('SH'*) .       1.648
RES HC VOID VOLUME ('SHR'*).       0.678
MOV HC VOID VOLUME . . . . .       0.969
******************************************


 N E T / G R O S S    R A T I O S
*****************************************

HNETPAY /HGROSS SAND =  1.00000
HNETSAND/HGROSS SAND =  1.00000
HNETPAY /HNETSAND    =  1.00000
*****************************************
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 S T A T I S T I C S
*********************

FIELD: . . . . . . . . . .          34/10-ALPHA
WELL:  . . . . . . . . . .             34-10-16
ENGINEER:  . . . . . . . . BH
DATE:  . . . . .           16.50   14 SEP 1983

DEPTH INTERVAL:  . . . 3412.00 TO  3475.00
APPLIED CUTOFFS:
.              VSH:  GREATER THAN       0.40
.             PHIF:     LESS THAN       0.10
.               SW:  GREATER THAN       0.65


 T O T A L   D E P T H
*******************************************
THICKNESS: . . . . . . . . .      63.000
AVERAGE   . . . 'PHIF'  . . .      0.113
AVERAGE   . . . 'VSHALE'  . .      0.166
AVERAGE   . . . 'SW'  . . . .      0.861
W.AVERAGE   . . 'SW' * 'PHIF'      0.807
AVERAGE   . . . 'SH'  . . . .      0.186
VOID VOLUME: . . . ('PHIF').       7.101
HC VOID VOLUME . . ('SH'*) .       1.491
RES HC VOID VOLUME ('SHR'*).       0.394
MOV HC VOID VOLUME . . . . .       1.097
*******************************************


 N E T     P A Y
*******************************************
THICKNESS: . . . . . . . . .       7.500
AVERAGE   . . . 'PHIF'  . . .      0.127
AVERAGE   . . . 'VSHALE'  . .      0.006
AVERAGE   . . . 'SW'  . . . .      0.550
W.AVERAGE   . . 'SW' * 'PHIF'      0.555
AVERAGE   . . . 'SH'  . . . .      0.450
VOID VOLUME: . . . ('PHIF').       0.950
HC VOID VOLUME . . ('SH'*) .       0.423
RES HC VOID VOLUME ('SHR'*).       0.168
MOV HC VOID VOLUME . . . . .       0.254
*******************************************


 N E T    S A N D
*******************************************
THICKNESS: . . . . . . . . .      42.750
AVERAGE   . . . 'PHIF'  . . .      0.141
AVERAGE   . . . 'VSHALE'  . .      0.067
AVERAGE   . . . 'SW'  . . . .      0.798
W.AVERAGE   . . 'SW' * 'PHIF'      0.798
AVERAGE   . . . 'SH'  . . . .      0.211
VOID VOLUME: . . . ('PHIF').       6.047
HC VOID VOLUME . . ('SH'*) .       1.263
RES HC VOID VOLUME ('SHR'*).       0.322
MOV HC VOID VOLUME . . . . .       0.941
*******************************************


 N E T / G R O S S    R A T I O S
*****************************************

HNETPAY /HGROSS SAND =  0.11905
HNETSAND/HGROSS SAND =  0.67857
HNETPAY /HNETSAND    =  0.17544
*****************************************
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<u>Quick look at thin sections.</u>

statoil

N O T A T

LAB
KAG/abf
15.8.83

TIL: Bengt Hultberg LET, Bergen

FRA: K. Gibbons, LAB

Kate Gibbons.

Twenty-five thin section from 3399.80 m - 3424.45 m core depth, 3403.80 - 3427.50 log depth were described. A list of the thin sections and their positions relative to the gamma-ray log is attached. The following is a summary of the observations made from the thin sections.

1. Thin sections from 3403.80 - 3410.30 (log depth) show mineralogies and textures similar to those of the Etive Fm as observed in other 34/10 wells. The average porosity within this depth range is 15-20 % (GECO, routine core analysis). Grain sizes are on the average medium. The grains are sub-rounded and sorting is moderate to good. Exceptions to this are 3403.80 (log depth) which has fine to medium lower grain size and 3407.50, 3408.40, 3410.30 in which grains sizes are medium to coarse. In these cases sorting is poor.

   The major detrital minerals are quartz, plagioclase, microcline and mica (approximately 5 wt % mica).

   Accessory minerals are ilmenite ($FeTiO_3$), zircon ($ZrSiO_4$), tourmaline, garnet and apatite (?).
   Zircon in the most dominant of all the accessory minerals. Thin sections from 3404.70 and 3405.65 contain the highest percent zircon (1-2 %). The increase in "Th" on the NGS log is probably due to the high concentrations of zircon - (Th replaces Zr in the zircon structure).

   Diageneic minerals are 1) kaolinite forming as a result of mica and feldspar breakdown.

Kaolinite is the major pore filling mineral. 2) Anatase (TiO_2) as small euhedral crystals or agglomerates of crystals occurs in pore space. Anatase is probably formed due to breakdown of ilmenite. 3) Siderite ($FeCO_3$), in minor amounts, forming around mica grains.
4) Pyrite

2. The transition from Etive to Rannoch is observed by 1) an increase in mica content (20 % mica) 2) a decrease in porosity from 15-20 % in Etive to 10 % in Rannoch, 3) a increase in K response on NGS log due to K content in micas 4) increase in siderite content.

3. The major detrital minerals in the Rannoch Fm are: quartz, microcline, plagioclase, and mica (20-30 %). Grains are on the average of medium size and sub-angular although after 3418.0 m (log depth) finer sands were observed. Sorting is moderate to well. Stylolites are developing along mica rich planes. Occasionally, a zircon or ilmenite grain was observed.

   Diagenetic minerals 1) kaolinite in pore space 2) anatase + pyrite due to breakdown of ilmenite and mica grains 3) small granular crystals of siderite develop around mica. There is an increase in siderite content in the Rannoch (up to 8 wt %). 4) Euhedral calcite grains are enclosed in siderite and grow along cleavage planes in mica.

4. At 3418.00 (log depth) there is a decrease in gamma log response, and an increase in porosity. This is probably due to a sudden decrease in mica content, down to <10 %. Grain sizes after this depth are very fine to fine.

5. From 3418.00 - 3427.95 m (log depth) there is a steady increase in calcite content and a decrease in siderite content.

6. The saw-edge appearance of the gamma ~~Foog~~ log after 3426 m (log depth) may be due to heavy mineral layers (ie zircon).

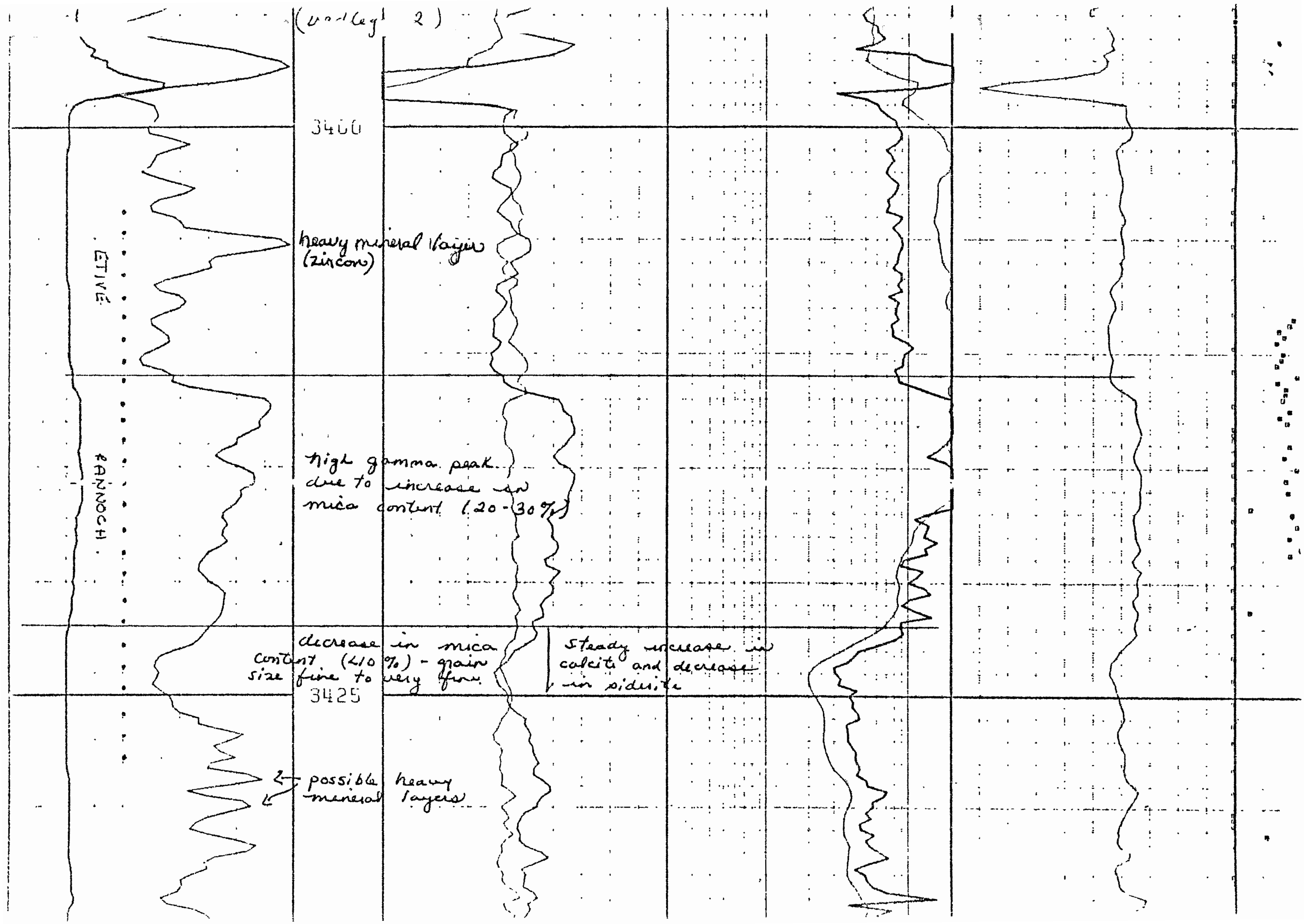
Vedlegg 1

34/10-16

thin section analysis:

List of thin sections:

core depth		log depth
3399.80	(n4.om)	3403.80
3400.70	(")	3404.70
3401.65	(")	3405.65
3402.60	(")	3406.60
3403.50	(")	3407.50
3404.40	(")	3408.40
3405.40	(")	3409.40
3406.30	(")	3410.30
3407.20	(")	3411.20
3408.10	(")	3412.10
3409.00	(")	3413.00
3409.90	(")	3413.90
3410.90	(")	3414.90
3411.85	(")	3415.85
3412.70	(")	3416.70
3414.40	(n 3.5)	3417.90
3415.40	"	3418.90
3416.45	"	3419.95
3417.45	"	3420.95
3418.40	"	3421.90
3419.45	"	3422.95
3420.45	"	3423.95
3421.45	"	3424.95
3422.45	"	3425.95
3423.45	"	3426.95
3424.45	"	3427.95


3400
heavy mineral layer (zircon)
ETIVE
RANNOCH
high gamma peak due to increase in mica content (20-30%)
decrease in mica content (<10%) - grain size fine to very fine
Steady increase in calcite and decrease in siderite
3425
possible heavy mineral layers

STATOIL DATA PROCESSING CENTER
PLOT MADE BY: HALVARD HAUKALID **DATE:** 14.49.42 5 SEPTEMBER 1983
DEPARTMENT : RES
ADDRESS/BOX : 30
OTHER INFO : -

BEREGNING AV LEIRINNHOLD
34/10-16, BRENT-RESERVOARET

GRAPHICAL LOG-PRESENTATION

WELL : 34-10-16 DEPTH INTERVALL :3160.00-3480.00 (METER)
ENGINEER :.A. HAGE SCALE 1:200
DATE: 14.49.49 5 SEPTEMBER 1983

STATOIL

Dybdereferanse: mRKB (RKB=25m)